ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

Vol. XXIV. No. 40.

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A RAILWAY LINE FROM NEWCHWANG TO KIRIN, CHINA, has been surveyed by Messrs. KINDER and COX. Few obstacles were encountered and a more careful survey will probably be made shortly. Mr. KINDER has had a long experience with Japanese and Chinese railways, and it is probable that he would not have undertaken this unpleasant work if it were not likely that the recent imperial decree permitting a loan for railway purposes will be followed by actual construction.

FOUR DECAPOD ENGINES for service in the new St. Clair tunnel are now building by the Baldwin Locomotive Works. They are to have 22×28-in. cylinders, 5 pairs of driving wheels, 49 ins. in diameter, and will weigh in working order, including 1,800 galls. of water in the tank, about 180,000 lbs. They will have boilers 74 ins. in diameter, carrying 160 lbs. of steam. The fire-box is 11 ft. long by 3½ ft. wide. There will be about 280 tubes, 2¼ ins. in diameter and 13 ft. 6 ins. long. The cab is placed centrally over the boiler. The wheel base is 18 ft. 3 ins. The second and fourth pairs of driving wheels will be flanged, the distance between their centers being 8 ft. 9 ins. The tires are to be secured by Mansell retaining rings, and each engine will be fitted with two sand boxes and two headlights, a Cooke steam bell-ringer, and the Westinghouse automatic brake, with equalized driver-brake fixtures acting on all of the wheels. The fuel will be anthracite coal or coke. The load which the engines are intended to haul is about 760 tons, on grades of 105.6 ft. per mile. They are to be delivered in January.

A COMPOUND PASSENGER LOCOMOTIVE is reported to have been satisfactorily tested on the East Tennessee, Virginia & Georgia R. R. The run was from Knoxville to Bristol, and 50 miles an hour is said to have been the speed maintained.

THE WORST ACCIDENT OF THE WEEK was a head collision of two freight trains due to "an operator's carelessness," on the Baltimore & Ohio R. R., near Pleasant Valley, O., in which eight were killed and two badly injured; some 25 cars and both the engines were smashed in the wreck. Another (tail) collision on the B. & O. Southwestern Ry., between a fast mail and a construction train, due to the latter occupying the track too long, caused one death. On the Kanawha & Michigan Ry., at Saltes, W. Va., one engine ran off, a second went to help it, leaving the switch open, a freight train ran into it, badly wrecking all three engines. A surprisingly large proportion of the serious accidents occurring of late are of the same general class as those above, which a block system, of any kind, would be likely to prevent. In England, where the block system and interlocking are all but universal, they are very rare.

A DERAILED TRAIN STRUCK A BRIDGE of the through lattice type on the New York Central & Hudson River R. R. at Albany, N. Y., Sept. 22, breaking two web members of one truss and several web members of the other, and bending the bottom chord. The violence of the blow was great enough to wreck 8 cars, and one wheel fell through into the street below. A like accident, destroying 9 cars, occurred on the same bridge about 11 months ago. In neither case was there any bridge failure or loss of life.

BIDS FOR CONSTRUCTION OF BATTLE SHIPS AND CRUISER were opened at the Navy Department Oct. 1. These include three coast line battle ships and one protected triple-screw cruiser, provided for by act of Congress, approved June 30, 1890. The bids were as follows:

William E. Cramp & Sons, of Philadelphia, offered to build one of the battle ships according to department's plans for $2,990,000, and two of them for $5,780,000; using his own plans will build one for $3,120,000, and two for $6,040,000. This firm offered to build the protected cruiser on department's plans for $2,725,000. The Union Iron Works, of San Francisco, offered to build one of the battle ships according to department's plans for $3,240,000, and two of them for $6,400,000. Their bid for the cruiser was $3,025,000. The Bath Iron Works, of Bath, Me., offered to build one of the battle ships in accordance with department's plans for $3,149,000, and the Risdon Iron Works, of San Francisco, offered to build one of that class of vessels for $3,275,000. There were no other bidders. In view of a provision of the law that one of the battle ships shall be built on the Pacific Coast, it is likely that the Union Iron Works will get the contract for one of the battle ships, and the Cramps will probably get the contracts for the other two battle ships and the protected cruiser.

THE HEAVIEST ARMOR ON BATTLESHIPS is carried by the English vessel *Inflexible*, which has two 12-in. wrought iron plates separated by 12 ins. of teak and backed by 6 ins. of teak, and two 1-in. iron plates. The thickest solid side armor afloat is that of the two Italian line-of-battle ships, *Duillo* and *Dandolo*, which consists of 22 ins. of solid plate of Schneider steel. It has greater power than the armor of the *Inflexible*. The *Admiral Baudin* and the *Formidable*, French battleships, have 22 ins. of Schneider steel, superior to that of the Italian vessels. Charles Cammell & Co., of England, are making compound plates of 8 ins. of steel and 16 ins. of wrought iron that are stated to have lately been most favorably tested in competitions with the 22-in. French plates.

A DYNAMITE PROJECTILE, on the rocket principle, is reported to have had a late very successful trial in England. The preliminary trial was on a comparatively small scale, but it is claimed that it was sufficiently conclusive to prove that great efficiency and range could be secured by placing the compressed air in the base of the projectile itself instead of using a specially constructed gun. With the new device the gun is a simple tube to be used for giving elevation; the release of a vent-closer in the base of the projectile allows the compressed air in the shell to re-act upon the breech of the gun and then upon the air itself, propelling the projectile as a war-rocket is propelled. We have no details as yet of the trial.

THE PROPOSED WIMAN'S TUNNEL between Middletown, S. I., and New Utrecht, L. I., was explained to the House Committee on Commerce at Washington, Sept. 22, by Mr. ERASTUS WIMAN, the President of the New Jersey & Staten Island Junction R R., the company which proposes to build the tunnel. It is reported that the committee will report favorably upon the project.

A TUNNEL UNDER THE FIRTH OF FORTH is being discussed by the Caledonian Railway Co. as a counterbalance to the advantages gained by rival corporations controlling the Forth Bridge.

THE NICARAGUA CANAL CO. has now a 9-ft. channel over the bar at Greytown. Two dredges have arrived from Colon, and a large amount of machinery and supplies have been received. There is a force of about 1,500 men now on the work. The general health of the employés continues excellent.

NICARAGUA CANAL BORINGS appear to indicate that the foundations of locks 1, 2 and 3, on the Atlantic side, will be a species of talc rather than hard rock, a fact which has both a favorable and unfavorable side; as a whole, it should not make any great difference. The bulk of the great divide cut is hard volcanic rock. The harbor work is proving very effective, the limited length of jetty already constructed having a decided effect to preserve and deepen the channel. All that we hear of the prospects of the enterprise is favorable to it.

INVESTIGATIONS REGARDING THE TORONTO WATER-WORKS are to be made at once by City Engineer W. T. JENNINGS and Mr. JOHN KENNEDY, Engineer of the Montreal Harbor Works, and one of the Consulting Engineers for the Toronto water-works. The engineers will report upon the cause of the recent breakdown of pumping engine No. 2, and upon additional pumping machinery. In our issue of last week we referred to the danger of a water famine in Toronto, and stated that the total pumping capacity of the works is but 22,000,000 Imp. galls., nominally, and much less actually. The Toronto *Globe* quotes from *The Manual of American Water-Works* figures regarding the pumping capacity, consumption and fire pressure in Buffalo, Montreal, Cleveland, Chicago and Milwaukee, all lake cities and drawing their water from a lake, as does Toronto. The figures show that Toronto has a smaller comparative pumping capacity than any of the cities named. Toronto is almost unique in that it has a large fire pressure. The *Globe* urges that in adding new pumping engines this be preserved, on account of the great saving in fire department expenses.

NATURAL GAS AS A FUEL AT THE DETROIT WATER-WORKS PUMPING STATION has been favorably reported upon by the Water Commissioners, and Secretary L. N. CASE has been instructed to draw up a contract between the city and the Michigan Gas Co., who propose to supply the works.

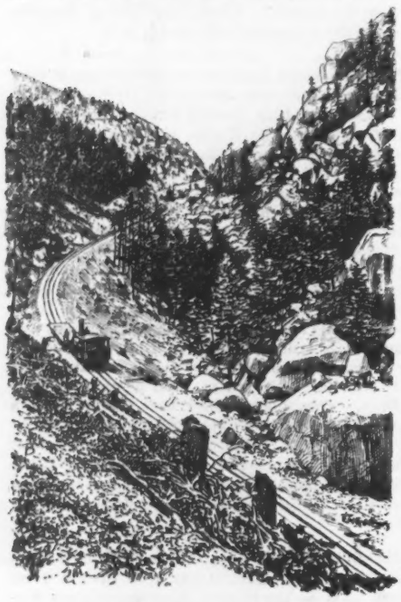
THE DEPARTMENT OF ELECTRICITY at Johns Hopkins University has attained a popularity and influence among practical electricians which must be rather mortifying to those members of the faculty who are fond of quoting Professor SYLVESTER'S answer to a question as to the use of the studies in that institution: "Thank Heaven, madam, they have no use." The department was bitterly opposed at the start, but it has grown with great rapidity under the direction of its head, Dr. LOUIS DUNCAN. It now maintains a very complete testing laboratory under the care of Dr. G. A. LIEBIG, JR.; while Mr. W. F. C. HASSON, Assistant Engineer U. S. N., gives instruction in mechanical engineering, and Mr. W. S. ALDRICH conducts a course of mechanical drawing and design.

ELECTRIC SNOW PLOWS AND SWEEPERS have been recently perfected by the Thompson-Houston Co. for use on electric railways. The plow truck is 20 ft. long, 7 ft. wide, and runs on 36-in. wheels. The snow is turned aside by two wings extending diagonally across the car, and the rails are cleared by two scrapers which can be raised or lowered by levers. Perfect contact between the wheels and rails is necessary in this system of propulsion, hence the addition of these scrapers. The car is propelled by a 20 HP. motor geared to each pair of wheels. The car for the snow sweeper is of the same dimensions, but is driven by two 15 HP. motors. The brushes for sweeping are of the same cylindrical form and arrangement adopted on the usual type of street sweeper and are rotated by separate motors at a speed of 200 revolutions per minute.

A LARGE ELECTRICAL PLANT run by water power has been nearly completed at Veazie, Me., 4 miles above Bangor. The power house is 240 × 52 ft., and contains 15 Holmes turbines of 150 HP. each, so arranged that they can be run separately or in groups. These wheels supply power to 2 alternating dynamos of 1,800 incandescent lamps capacity each, 4 arc and 3 power machines. The plant will supply the lights of Bangor and Brewer, power to the Bangor & Brewer Electric Ry., and also the power to the water works of Brewer and Veazie. Mr. D. B. WHITNEY is the engineer connected with the work.

The Pike's Peak Rack Railway

The Manitou & Pike's Peak Ry. Co., was organized with a capitalized stock of $500,000, in the fall of 1889 for the construction of a railway 9 miles long, from Manitou to the Old Signal Station on Pike's Peak. Its directory was composed of a number of prominent men interested in connecting railways and resorts in the vicinity. Mr. R. E. BRIGGS, then of



View of Part of Pike's Peak Rack Railway.

the Denver & Rio Grande Ry., was Chief Engineer, and THOS. F. RICHARDS, Contracting Engineer.

Directly after this organization was effected work commenced, and since then has been systematically and diligently prosecuted, nearly 1,000 men having been constantly employed. It would have been completed and the entire line now in operation, but for unforeseen delays in the manufacture and shipment of requisite material and equipment. The road, as our readers have been informed in previous issues, is built on the Abt system, under the supervision of Mr. W. HILDEBRAND, the American representative of the Swiss inventor, ROMAN ABT, and as regards grades surmounted, is perhaps the steepest and most important Abt line in the world. The Mt. Washington line has considerably steeper grades, very nearly 33⅓%, but is not of the Abt type. The Rigi has a short piece of 30 per cent.

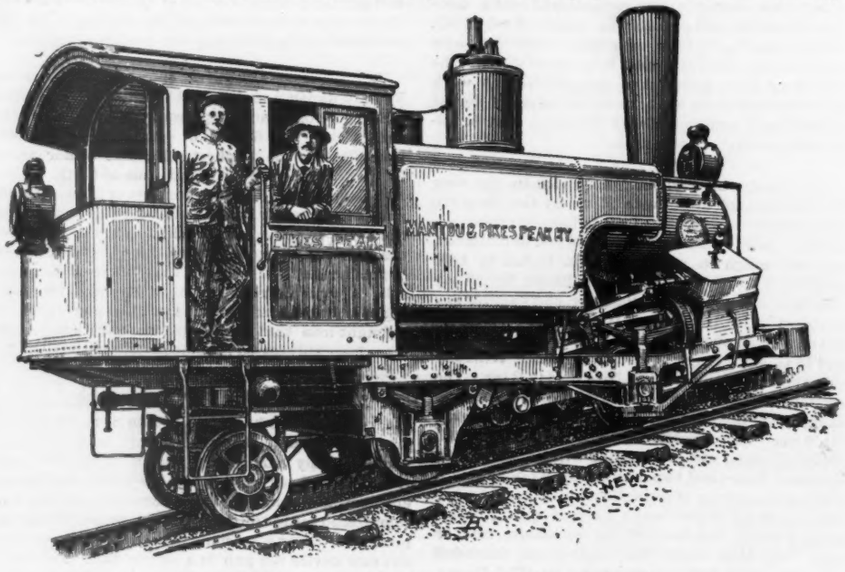
The exact length is 46,158 ft., or very nearly 8¾ miles. The altitude of its initial station at Manitou is 6,600 ft.; at the summit it is 14,200 ft. above sea level; the total ascent being 7,600 ft.; or an average of 846 ft. per mile. The maximum grade is 25%, over 22% of the line having a grade of from 22½% to 25%. The grades of the entire line are very nearly as follows: 10,229 ft. at 22½% to 25% (1,188 to 1,320 ft. per mile); 6,820 ft. at 19½% to 22½%; 7,675 ft. at 15½% to 19½%; 4,295 ft. at 12½% to 15½%, and 17,139 ft. at 12½%, or less, per mile.

The line is tolerably crooked, even for an adhesion road, and has many sharp curves. Of straight line there is 28,378 ft., and of curved, 18,477 ft., about 39% of the line being on curves. The total curvature is over 1,844°, or about 211° per mile. The sharpest curves are 16°, of which there are many. The road bed is an excellent example of the usual type of mountain roads. The foundations are firmly secured, and further protected and sustained by wide embankments wherever practicable. The culverts (of which there are many) are of stone. There are 4 iron bridges, 2 of 20 ft. and 2 of 30 ft. span, resting on masonry abutments. The rails are laid on red spruce and oak ties, 8 ins. face, 7 ins. deep, 9 ft. long, laid 20-in. centers.

At intervals of 200 to 600 or 1,000 ft., depending upon the grades, anchorages are made by straps fastened to the ties and carried up grade to eye-bolts set in solid blocks of masonry. As the whole track is tied together, not only by the spiking, but by the extra fastenings of the rack rail, it is thought that these anchorages will be amply sufficient to guard against the movement of any part down grade.

The track rails are 40 lbs. per yd., 3½ ins. high, and were made by the Illinois Steel Co. The rack rails consist of two rack bars set side by side in chairs. They are 4⅝ × ⅞ ins. and 4⅝ × 1¼ ins. according to the grades. Each section is 80 ins. long and the chairs are 40 ins. apart on each second tie, the rack bars breaking joint according to the usual Abt practice. The teeth are 2 ins. deep and 4.7 ins. pitch. The material of the racks is Bessemer steel, 70,000 lbs. ultimate strength, 25% elongation in 8 ins. and 45% reduction of area. The chairs are of the same steel as the racks, rolled and die forged, and are fastened to the ties by 1-in. wood screws. Rails, racks and chairs were all manufactured to order by the Johnson Works, at Johnstown, Pa.

Three locomotives on the Abt system, each weighing 25 tons, have been built for the line by the Baldwin Locomotive Works; the first engine arriving at Manitou on May 24. It bears the name of JOHN HULBERT, the originator of the Pike's Peak project and President of the company. In one of our illustrations we give a view of one of the engines, engraved from a photograph. The cab and boiler are much like those of any other steam engine, but the intricate machinery underneath is wholly unlike that of an ordinary locomotive. The wheels bearing on the rails are merely bearing wheels, not drivers, the plant differing in this respect from some other Abt engines which work either by adhesion or rack indifferently. The Pike's Peak line being all on rack grades this double provision became superfluous. The engine is propelled by three sets of gearing directly over the center of



LOCOMOTIVE FOR MANITOU AND PIKE'S PEAK RY.

the track. On these are six pinions with steel teeth 2½ in. thick, which fit into the two rack-rails running along the center of the track. The propelling power is applied directly to a drum above the two rear pinions. The front pinions are moved by a connecting rod running from the second one. The brake apparatus is especially powerful, very naturally. On either side of the pinions is a corrugated surface which a steam brake presses against them with tremendous force. The engine is also fitted with hand brakes and the Le Chatelier water brake, by which the cylinders act as brakes, which is so effectively and largely used on mountain grades. The tank will hold 700 gails., and must be filled four times in each round trip. One engine will push two cars weighing 42,000 lbs. loaded. The average speed will be five miles an hour; on the 25 per cent. grades it will be three miles per hour, and on the eight per cent grades eight miles.

Six passenger, two observation and two flat cars were ordered of the Wason Manufacturing Co., of Springfield, Mass. Each passenger car has 25 seats with a capacity for carrying 50 persons per trip, and weighs 21,000 lbs. when loaded. It is also supplied with two tension brakes to be worked by hand. The cars are not tilted, but the seats are so arranged as to give the passenger a level footing. The engine, instead of drawing, pushes the cars, as usual. The cars can also be let down hill independently of the engine, if necessary.

Had not the work been retarded by the inability of the manufacturers of engines and cars to complete their contracts on time, the entire line would have been ready and open for business July 1, as anticipated. The grading to the summit was finished some time ago. The roadbed, 15 ft. in embankment and 22 ft. in excavation, is all good, no bad material having been used. From its Manitou station, the line runs up apparently vertical cliffs through Engleman cañon until a succession of small, but beautiful grass-covered parks is reached. About 1¼ miles from Manitou, at "Artist Glen," magnificent views are obtained of the surrounding country, including the Garden of the Gods, and the vast plains stretching east. Sharp grades are first encountered on the second mile from Manitou station. The steepness of this incline is admirably illustrated in our view of the "Grand Pass," engraved from a photograph. All work above timber line for 2¼ miles is largely in embankment to avoid difficulty from snow. Below the timber line, it is largely in excavation, as owing to the steepness of the mountain sides it was difficult to build embankments.

In our issue of May 22, 1886, and in many issues since, we gave a general description of the Abt system. On Aug. 15 we gave the latest construction news, showing the line to be now practically complete, but not likely to open till next year. Some years before this project was started an ordinary 4% (we believe) adhesion road was projected and partially graded, but funds gave out before the grading was nearly done.

Municipal Engineering in Liverpool.

The city of Liverpool deservedly enjoys the reputation of being one of the best administered cities of the world in respect to the numerous problems of municipal engineering which it seems to be so hard to have decently administered in this country. This lends especial interest to a recent consular report by U. S. Consul SHERMAN, which, albeit in many details only repeating what has already appeared in this column, we abstract as follows, "for reproof and instruction in righteousness." We italicize a few specially significant and interesting facts:

The population is estimated at nearly 600,000; the city area is 5,210 acres, which corresponds to 115 inhabitants per acre or 73,600 per square mile. It is said to be the most densely populated city in Great Britain. Comparing with other cities, details of which were given in our issue

of May 12, 1890, we have for the population per square mile:

Liverpool	73,600	New York, 14th to 40th St.	106,990
London	32,610	New York, 40th to 86th St.	65,176
London, most crowded district	83,840	New York, island, av.	66,300
Paris	74,880	Brooklyn, most cr'ded district	71,377
Philadelphia	60,600		
New York, below 14th St.	150,920		

[The death rate during the last year was 20.3 per 1,000; the total number of deaths, 12,159, was some 2,000 below the average of the last ten years. The death rate in San Francisco is 19.17; Chicago, 17.91; New Orleans, 33.91; Baltimore, 28.51; Boston, 19.11; St. Louis, 26.77; New York City, 25.13; Brooklyn, 24.45; Philadelphia, 23.07. The above are the latest returns as given monthly in *The Sanitarian*.—ED.]

STREET PAVEMENTS.

The method of laying pavements according to the subjoined specifications was begun in 1872, and the city now possesses some 1,750,000 sq. yds. of impervious paving on 254 miles of streets. The financial success is certainly great. In 1879, under MR. CLEMENT DUNSCOMBE, M. Inst. C. E., the present able and faithful City Engineer, the expenditure for repairing the 226 miles of streets then constructed was $136,080. The expenditure under this head has been steadily reduced year by year until, in 1889, the amount was only $40,824, although the mileage was 28 greater.

The following specifications are for the three classes of pavements employed, the first class being laid in the main streets subjected to heavy traffic. *Permission is never given to private companies to cut through the pavement for any purpose.* The corporation does this work in its own way, and the interested parties pay the entire cost.

PAVING SPECIFICATIONS.

First-class streets.—Excavate or fill in the ground, as the case may be, to the requisite level, and remove all surplus material. Properly form and trim off the surface and thoroughly consolidate same, and then lay a foundation of not less than 6 ins. of Portland cement concrete corporation standard. The paving shall consist of granite or syenite sets, 3¼ ins. wide by 6¼ ins. deep, from North Wales or other approved quarries, laid in regular, straight, and properly bonded courses, with close joints, and to be evenly bedded on a layer of fine gravel half an inch in thickness. After the paving is laid the joints shall be filled with hard, clean, dry shingle; the sets shall then be thoroughly rammed and additional shingle added until the joints are perfectly full. The joints shall then be carefully grouted until completely filled with hot asphalt, composed of coal pitch and cresote oil, and, finally, the paving is to be covered with half an inch of sharp gravel.

The crossings shall consist of 3 rows of 16 × 8 in. granite crossing stones, and the remaining space shall be paved on each side of the crossing stones to the full width of the foot-way, in a similar manner to the carriage-way. The crossing stones shall be of granite of a quality to be approved by the engineer, dressed perfectly true, and out of winding on the face; the sides and joints to be perfectly square and accurately dressed throughout their entire depth; the stones to be bedded on cement concrete, the joints to be filled with shingle and grouted with hot asphalt. A triangular groove an inch wide by three-fourths of an inch deep to be run along the upper surface of each stone. No stone to be less than 3 ft. in length.

The foot-ways shall be paved with Yorkshire or Lancashire flags of the best quality, not less than 3 ins thick. No flag to measure less than 2 ft. in width, or to be of less area than 6 sq. ft.; to be solid, free from laminations, the upper surface to be true and free from windings or hollows; the joints to be squared the whole thickness. The flags to be laid on a bed of fine gravel, with close, neat joints flushed in mortar, and in uniform courses breaking bond. The joints to be dressed after laying, where necessary.

The channel stones to be of granite or syenite, of a quality to be approved by the engineer, and to be not less than 3 ft. in length. The upper surface, if not self-faced and perfectly true, must be accurately worked out of winding, the bed even and parallel to the face, the sides and ends truly square; the stones to be bedded on cement concrete, and the joints to be filled with clean shingle and grouted with hot asphalt.

The curbstones to be granite or syenite, straight or circular as required, 6 ins. thick at top, 7 ins. thick at 5 ins. below, and not less than that thickness for the remainder of the depth; to be not less than 12 ins. deep nor less than 3 ft. in length; to be carefully dressed on top, 8 ins. down the face, and 3 ins. down the back; the remainder of each stone to be hammer dressed; the heading joints to be neatly and accurately squared throughout the entire depth.

Second class streets.—Excavate or fill in the ground, as the case may be, to the requisite level, and remove all surplus material; properly form and trim off the surface and thoroughly consolidate the same, and then lay a foundation of (*a*) not less than 6 ins. of Portland cement concrete, corporation standard, or (*b*) not less than 6 ins. of bituminous concrete, consisting of clean and angular broken stone, grouted with hot asphalt composed of coal pitch and creosote oil, covered with chippings, and thoroughly consolidated by rolling with a roller or sufficient weight. The pavement shall consist of granite or syenite sets 3 ins. wide by 5 ins. deep, or of granite or syenite 4 × 4-in. cubes from North Wales or other approved quarries, laid in regular, straight and properly bonded courses, with close joints, and to be evenly bedded on a layer of fine gravel half an inch in thickness. After the paving is laid the joints shall be filled with clean, hard, dry shingle; the sets shall then be thoroughly rammed and additional shingle added until the joints are perfectly full. The joints shall then be carefully grouted until completely filled with hot asphalt composed of coal pitch and creosote oil, and, finally, the paving shall be covered with half an inch of sharp gravel.

The crossings, footways, channels and curbs shall be the same as specified for first-class streets.

Third-class streets.—Excavate or fill in the ground, as the case may be, to the requisite level, and remove all surplus material; properly form and trim off the surface and thoroughly consolidate the same, and then lay a foundation of hand-pitched rock 6 ins. in depth, set on edge in the manner of a rough pavement. Over this a coating of gravel is to be laid of sufficient thickness to fill in the interstices and to form a smooth surface to the foundation, which may be thoroughly consolidated by rolling with a steam-roller before the paving is laid. The paving shall consist of 4 × 4-in. granite or syenite cubes from North Wales or other approved quarries, laid in regular, straight, and properly bonded courses, with close joints, and to be evenly bedded on a layer of fine gravel half an inch in thickness. After the paving is laid the joints shall be filled with clean, hard, dry shingle; the sets shall then be thoroughly rammed and additional shingle added until the joints are perfectly full. The joints shall then be carefully grouted, until completely filled up, with hot asphalt composed of coal pitch and creosote oil, and, finally, the paving shall be covered with half an inch of sharp gravel.

The crossings, footways, channels, and curbs shall be the same as specified for first-class streets.

STREET RAILWAYS.

All the street railway tracks are laid and owned by the city, and kept in condition by the corporation. The company leasing them pays 10% on the cost as an annual rental.

[TO BE CONTINUED.]

Ore-Dressing By Electricity at the Tilly Foster Mine.*

The electro-magnetic separator of Mr. G. CONKLING, of Glens Falls, N. Y., described by Mr. BIRKINBINE in a paper at the New York meeting of the Institute, in February, 1889, has been in successful operation at the Tilly Foster mine for a considerable period, under the disadvantages which seem to be the inevitable attendants of pioneer enterprises in new technical fields. The results of a run of several months, which the Superintendent, Mr. S. P. TOMKINS, has taken pains to collate, are here presented by his courteous permission, and that of Mr. E. S. MOFFAT, the energetic and skilful General Manager of the Lackawanna Iron and Coal Company, to whom our profession is already indebted for examples of bold and ingenious practice in mine engineering. It is believed that these figures will assist those who are planning similar operations to decide intelligently what they may, and, more important still, what they may not, expect to accomplish

The local difficulties in the way of this experiment at the Tilly Foster mine were many and great. Only about two thirds of the waste-dump, resulting from the assorting of previous years, is ore; and this varies in contents of iron from 20 to 28%. The remainder is rock, some (from horses in the vein) showing particles of adhering mineral, some (from the foot and hanging walls) entirely barren. The expense of overhauling the dump and removing this rock is by no means the least of the numerous items which must be charged against the concentration. Associated with the lean ore are hornblende and other minerals, carrying iron in the non-magnetic state, which must necessarily be washed away with the tailings. The waste-dump was originally located without reference to future treatment, and now can only be handled by means of a locomotive, operating over heavy grades.

The mineral is so widely and finely disseminated through the ore that it has been necessary to resort to fine-crushing. This (water being used in the separation) increases the proportion of slimes, which carry off mechanically small particles of mineral. Finally, the lean character of the ore calls for the handling and conveying from the mill of a large bulk of tailings. The process includes crushing the ore by a Blake rock-breaker on the dump; removing it in train-loads to the bins in the mill; passing it under two Ball stamps, provided with screens of 5-16 in. mesh; elevating it to the Conkling electrical separating belts; and delivering the concentrates to the cars and the tailings to the settling reservoirs. It all seems simple enough in a printed description; but many practical difficulties have been met and overcome by Mr. Tomkins, to appreciate which one must visit the works and note the changes which have been made from time to time with increasing experience. In the face of these changes and the frequent accidents and breakdowns incidental to the introduction of new machinery, the mill has been kept running almost continuously 10 hours out of the 24, and this has contributed not a little to the success of the undertaking.

By reference to the accompanying table it will be noted that, during the six months ending July 31, 1890 (the work of January being omitted from the calculation), there were treated 18,058 tons of lean ore, an average of 3,009 tons per month. The concentrates produced amounted to 6,236 tons, an average of 1,039 tons per month. There were required, therefore, 2.89 tons of crude ore to produce one ton of concentrates. The average cost of treatment, including preparing the ore and getting it to mill, and disposing of the tailings (which items make up one-half of the charge for labor), was $2.25 per ton of concentrates. The actual expenses in the mill have averaged $1.63 per ton of concentrates. These figures will be materially reduced when the supply of waste ore from the dump has been exhausted, and a higher grade of lean ore is sent directly from the mine to the mill.

Since the following table was compiled the figures for August, 1890, have been received. They show 1,391 tons concentrates from 3,508 tons of crude ore, or 1:2.52. The cost per ton of concentrates was $1.89, as compared with $2.39 in July. The reduction of cost is due to the increased output of the mill in concentrates, a larger amount of crude ore having been treated, and also a larger yield obtained per ton of crude ore.

The following practical conclusions are suggested by these results:

TABLE OF RESULTS FOR SEVEN MONTHS OF 1890.

	January.	February.	March.	April.	May.	June.	July.	Average for 6 mos. Beginning Feb. 1.
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
Ore used	1,719	3,007	2,278	3,104	3,619	3,129	2,930	3,009
Concentrates made	445	893	785	1,254	1,176	1,062	1,066	1,039
One ton of concentrate from	3.75	3.36	2.90	2.47	3.07	2.93	2.61	2.89
Labor: Crude to crusher, crushing and loading cars, repairing cars, carts and wheelbarrows, and of locomotive crew		$0.66	$0.59	$0.47	$0.60	$0.63	$0.66	
Labor in mill work and handling concentrates		0.48	0.54	0.37	0.42	0.45	0.41	
Labor in ore bins		0.07	0.08	0.06	0.07	0.06	0.06	
Labor handling tailings			0.03	0.01	0.03	0.03	0.02	
Labor in repairs of mill and machinery			0.17	0.06	0.08	0.10	0.11	
Analyses							0.03	
Material for repairs		0.40	0.17	0.18	0.19	0.23	0.27	
Supplies, oil, waste, etc		0.16	0.23	0.07	0.21	0.21	0.16	
Coal used		0.66	0.74	0.53	0.55	0.63	0.61	
Total cost of one ton concentrates	$3.03	$2.43	$2.55	$1.75	$2.15	$2.34	$2.39	$2.25
Cost of labor in one ton concentrates		$1.41	$1.40	$0.97	$1.20	$1.27	$1.32	$1.26
Cost to crush and put crude ore in mill		.19 7-10	.20 3-10	.18 9-10	.19 6-10	.21	.25 3-10	
P. c. of iron in crude ore sent to mill	25.13	24.96	28.57	28.21	26.80	28.28	27.55	27.39
P. c. of iron in concentrates	47.40	50.20	49.54	48.75	50.19	51.04	49.14	
P. c. of iron in tailings					11.53	10.32	10. 1	
Mill run Days		20 8-10	15 7-10	23 8-10	25 3-10	22 2-10	22 2-10	

1. Unless the location and other conditions are exceptionally favorable, it will not pay to erect works to treat the material of waste-dumps carrying less than 25% of iron.

2. Where the lean ore is mined in connection with shipping ore, there must be a corresponding increase in the percentage of iron to offset the mining and royalty charges.

3. Where no shipping-ore is produced, there must be a still further increase in the percentage of iron, to warrant the erection of hoisting, pumping and dressing works.

Mine-owners will readily understand that no rigid rules can be laid down where the ore-characteristics and local conditions are constantly varying. Before establishing large works, the most thorough and comprehensive tests should be made.

*A paper by F. H. MCDOWELL, New York City, presented at the New York Meeting of the American Institute of Mining Engineers.

The St. Clair Tunnel.

I.

The most renowned achievements in all departments of human activity owe their importance and fame to the magnitude of the obstacles surmounted. There is now approaching completion near the outlet of Lake Huron, a railway tunnel beneath a river, which, by reason of the difficulties successfully overcome, and the importance of the completed work, is entitled to high rank among the great engineering works of the continent. Because of its

importance and the fact that the method of working is in many respects an entire novelty, we have secured, through the courtesy of the Chief Engineer, Mr. JOSEPH HOBSON, complete details of the work and the methods and machinery employed. These we shall present in series of articles, for the preparation of which an examination of the work has been made; and Mr. HOBSON has kindly consented to aid in making the description correct and complete.

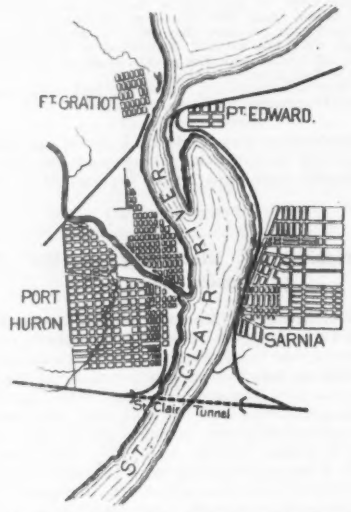
The natural overland highway to the Atlantic seaboard for the products of the West, which are gathered at the markets of Chicago, is along the level plain which borders Lake Erie, and thence either east by the route taken by the New York Central, or northeast down the valley of the St. Lawrence.

But unless a long detour be made to the south of Lake Erie, the traffic which takes this easiest route must cross the St. Clair or Detroit rivers, which, with Lake St. Clair, form the connection between Lakes Huron and Erie. These rivers are wide and deep with a rapid current. The traffic which passes up and down them exceeds that which enters and leaves the port of New York. If crossed by a bridge, therefore, it must have but a single span, and must rival in size and expense the greatest bridges of the world. Moreover, the nature of the banks is such as to make the building of foundation work difficult and uncertain; and the stretch of level plain which borders the river on either side would make the approaches to a high-level bridge seriously expensive.

Nor has the outlook for tunneling beneath the bed of the river been a favorable one. The bed of the river is of sand and gravel, underlaid by a soft clay. This rests on rock at a depth too great to make a tunnel through the latter feasible, even if it were of such a nature as to promise success to an attempt to tunnel through it.

THE DETROIT RIVER TUNNEL.

On the other hand the delay and expense of ferrying all traffic across these rivers has grown yearly more serious. As long ago as 1867 Mr. JAS. F. JOY, then president of of the Michigan Central R. R., engaged the late E. S. CHESBROUGH to investigate the feasibility of a tunnel under the Detroit River and in 1872 work was commenced. It was proposed to make a tunnel 8,000 ft. long, of which 3,000 ft. would be under the river. The tunnel was to be 18½ ft. in diameter inside, lined with brick masonry 24 ins. thick, and was to be drained by a smaller drainage tunnel below it and parallel to it of 5 ft. diameter. It was deemed best to excavate the small drainage tunnel first, and work was carried on until 1873, when it was abandoned on account of the difficulties encountered. These were chiefly the sudden irruptions of sand and water under a pressure higher than that due to the head from the river above. The drainage tunnel was driven 1,220 ft. from the shore shaft on the Detroit (American) side, and about 450 ft. on the Windsor (Canadian) side. The tunnel and shafts were allowed to fill up



Map Showing Location of St. Clair Tunnel.

with the water, the directors concluding that it would be throwing good money after bad to spend more upon the work.

THE GRAND TRUNK RAILWAY SYSTEM.

By reference to our map of the railway systems east of Chicago, published Nov. 10, 1888, it will be seen that the tunnel under the Detroit River would have been chiefly beneficial to the Michigan Central Ry. The Grand Trunk Ry. system, however, sends the great bulk of its traffic across the St. Clair River, near the outlet of Lake Huron, 60 miles north of Detroit. At Port Huron, on the west bank of the St. Clair, terminate four lines of railway. The most important of these is the Chicago & Grand Trunk, which furnishes the outlet to Chicago for the whole Grand Trunk system, over 4,100 miles in extent. On the east terminate the two main lines of the Grand Trunk's Canadian system. One running direct to Toronto and Montreal, the other (the old Great Western Ry.) running to the Niagara river, and connecting there with the trunk lines to New York.

The gross earnings, passenger mileage, and ton mileage per mile of the Chicago & Grand Trunk Ry., which became part of the Grand Trunk system in 1879, were as follows in 1889 and 1884:

Per Mile.	1884.	1889.
Gross earnings	$9,368	$10,082
Passenger mileage	184,352	184,283
Ton mileage	1,135,477	1,169,306

It will be seen that the traffic is very heavy, especially as regards freight carried, but it has remained nearly stationary for five years past.

In 1888 the total number of cars ferried across the St. Clair river by the Grand Trunk Ry. was: freight cars, all kinds, 296,908; passenger cars, 27,667; baggage and mail cars, 7,920. Estimating the number of working days in the year as 331 (allowing one-third the work to be done on Sunday that is done on week days), this would give an average of 1,004 cars transferred per day.

While the river is narrow at the point where the transfer floats ply, the current is swift—from 4 to 7 miles per hour; ice causes great annoyance in winter, and the many vessels passing up and down the river cause yearly greater delays and dangers in ferrying. In transferring through passenger trains the total delay amounts frequently to half an hour or more.

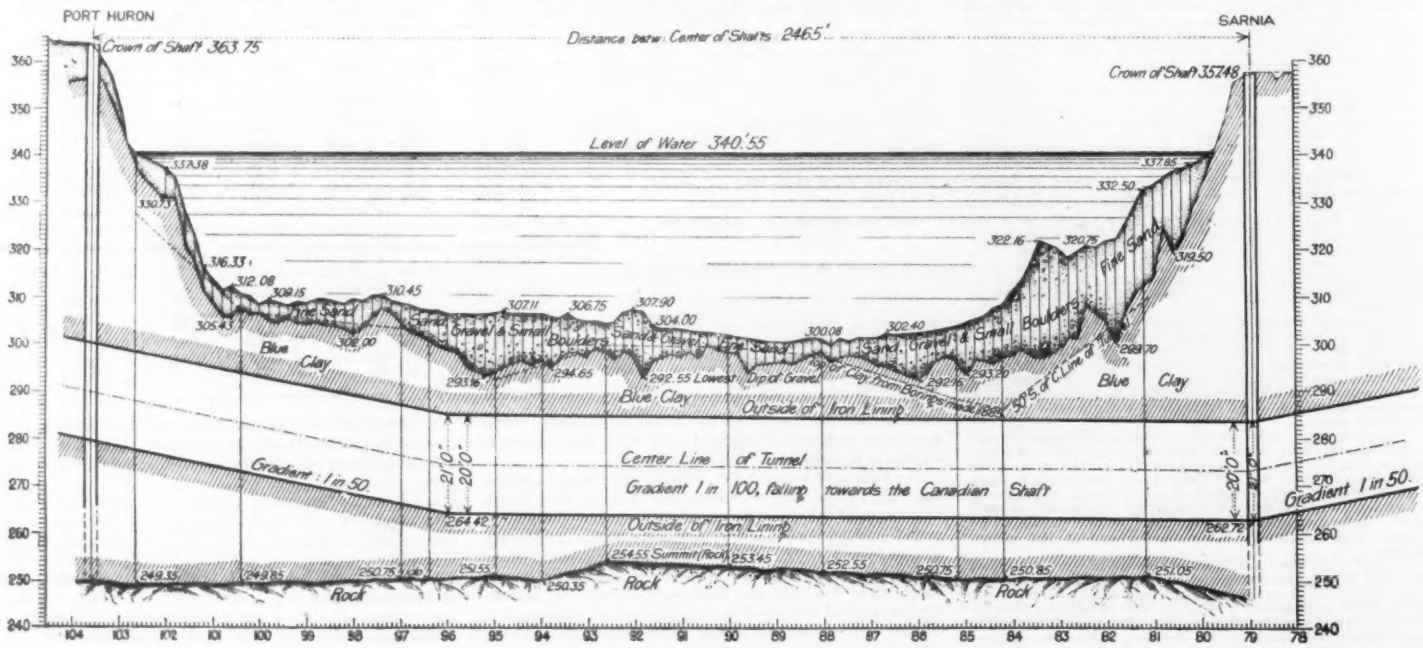
SURVEYING FOR THE TUNNEL.

The importance to the Grand Trunk Co. of securing some better means of crossing the St. Clair than a ferry transfer was much increased when in 1879 the company secured control of the Chicago & Grand Trunk Ry. and became an active competitor of the trunk line railways for traffic from Chicago to the Atlantic seaboard. Notwithstanding the disastrous failure of the Detroit River Tunnel and the probability that similar difficult material lay beneath the St. Clair river, Sir HENRY TYLER and Sir JOSEPH HICKSON, President and General Manager of the Grand Trunk Ry., were loth to believe that a tunnel beneath the St. Clair was impracticable, especially as its necessity became more apparent.

In 1882 WALTER SHANLY, of Montreal, was asked to report upon the feasibility of the enterprise. He made a reconnoisance but no surveys or borings and reported that if a tunnel were driven the most favorable site would be at Port Huron, three miles south of the present ferry crossing of the Grand Trunk.

In 1884 the St. Clair Tunnel Co. was incorporated in Canada by officers of the Grand Trunk Ry.: President Sir HENRY TYLER being at the head, and Mr. JOSEPH HOBSON, Chief Engineer of the Great Western division of the Grand Trunk Ry., was appointed Chief Engineer. Mr. HOBSON at once made careful surveys to determine the best location for the tunnel, and found that the location recommended by Mr. SHANLY two years beforo was the best available. It was therefore adopted.

By reference to the accompanying map it will be seen that an incidental advantage of this site is that



PROFILE OF PART OF ST. CLAIR TUNNEL UNDER RIVER SHOWING SECTION OF RIVER BED AS DETERMINED BY BORINGS.

it shortens by 6 miles the principal through line of the Grand Trunk Ry. The Chicago & Grand Trunk on the west and the Great Western division on the east both run to a point near the bank of the river and then make a detour of 3 miles to the north to reach the ferry transfer.

In 1885 borings were made to determine the material to be penetrated. To avoid disturbing the ground through which the tunnel was to be driven, these borings were made on a line 50 ft. south of the center line of the tunnel. In making the borings for the river portion of the tunnel a scow was towed out in the river and solidly anchored by lines in every direction. A 6-in. wrought iron pipe was then driven down into the river bottom by a pile driver, often clear through the sand and gravel to the clay. The pipe was in 12-ft. sections coupled with screw joints. The borings were made inside this pipe as on land.

The accompanying profile shows the depths of the bed rock as determined by the borings made in 1885, and also shows by a broken line the top of the clay stratum as determined by these borings, which it will be noticed were made at considerable intervals, only 11 being made in the whole width of the river

The knowledge gained by these borings was not encouraging. It appeared that the material to be penetrated was very similar to that which had caused the abandoment of the work at Detroit after the most persistent attempts to overcome the difficulties. The river bed was composed of fine sand and gravel. The clay substratum was not a solid impervious hardpan (as many have been led to suppose since the tunnel's completion from the rapidity with which it has been driven), but a soft yet tenacious material, permeated with water and promising to be most unstable in working.

A PRELIMINARY TUNNEL.

After these borings were completed, Sir HENRY TYLER came on from England, and a consultation was held as to the best method of procedure in view of the difficulties found. Chief Engineer HOBSON advised that, before the full size tunnel was attempted, a small drift be carried part way through, with its top about on a line with the top of the proposed tunnel. Thus an accurate idea of the material and the best mode of working it would be obtained. If this could be carried through successfully, the proposed tunnel could doubtless be put through. If insurmountable difficulties were encountered, the money lost would be less than if the full size tunnel were attempted. Moreover, this plan of operation had already been tried at Detroit, and had advanced very far toward success.

It was decided that Mr. HOBSON'S plan should be adopted, and work was immediately begun under his direction. A small shaft was rapidly sunk on each bank of the river to a depth of about 75 ft., or 60 ft. below the level of the water surface and from its bottom a drift was started beneath the river. On the American side the drift was advanced less than 20 ft., and the clay proved so bad that no further progress could be made. On the Canadian side the workmen succeeded in pushing the drift out 186 ft. beneath the river. Gas, water and quicksand were encountered, and the work was prosecuted with the greatest difficulty and danger. An explosion of gas at one time came near causing fatal results. The drift was excavated in the ordinary way, without the aid of shields or compressed air.

Several months were occupied in this work, and when it was finally concluded to give up trying to push the drifts farther wooden bulkheads were built in the ends of the drifts, and these and the shafts were allowed to fill with water.

Nothing further was done until the spring of 1888, when the managers of the company decided to begin building the full-size tunnel.

The plans of the work had been submitted to the Dominion Government, and it had been arranged that the enterprise should be aided by a government subsidy of $375,000, or 15% on the total estimated cost, $2,500,000. The Grand Trunk Ry. Co. agreed to guarantee the interest on the bonds of the St. Clair Tunnel Co., and thus arrangements were made for ample capital to carry on the work.

LOCATING THE TUNNEL IN THE CLAY.

Up to this time no borings had been taken on the line of the tunnel, the borings made in 1885 on the line 50 ft. south being relied on to indicate the material to be penetrated. On May 7, 1888, the boring scow began work directly on the center line of the tunnel and borings were made at intervals of 20 ft. all the way across the river. These borings extended only to the top of the clay, however, as it was desired to avoid disturbing the strata through which the tunnel was to be pierced. The 6-in. pipe was sunk to the clay by attaching a water jet to the base, as in pile driving, for a considerable percentage of the borings. Elsewhere a pile-driver was used.

The profile as determined by these borings is shown in the accompanying drawing. It will be noticed that at one point near the Canadian shore the top of the clay as determined by the borings of 1885 is much lower than that indicated by the borings of 1888. It is now believed that this was due to the boring tube in 1885 striking a small boulder at this point which was driven down before it for about 10 ft., thus giving an incorrect indication of the depth of the clay. The incident illustrates well the exceedingly soft nature of the material penetrated by the tunnel.

The scow made 110 borings, which occupied 70 days, the work being completed July 16, 1888. The difficulty of the work was much enhanced, however, by the number of vessels passing up and down the river and the general enmity of the boatmen to the enterprise, which could hardly have been greater if a bridge instead of a tunnel had been in contemplation. Several times the boring scow was struck and driven from her moorings by passing boats, and this, of course, caused great delay to the work. The total cost of the 121 borings taken in 1885 and in 1888, was about $5,000.

From the data furnished by these borings it was necessary to decide upon the proper depth for the tunnel. The clay stratum was shown to be only 38 ft. thick at the thinnest part, near the center of the river. Through this an excavation was to be made 21 ft. in diameter. Under ordinary circumstances the tunnel would have been located much closer to the rock than to the top of the clay. Here, however, the dangers which lay in the rock strata were believed to be little if any less than the dangers from the river above.

The rock is a loose porous shale, of the same formation as that which furnishes gas at many points in the vicinity. Gas was encountered in quantities at the Detroit tunnel, and, as already stated, had already been found here and had caused one explosion in the experimental drift. The line between the clay and rock, moreover, was hardly the well defined one shown on the drawing. The lower layers of the clay contained a considerable amount of rock, and as the borings to rock were comparatively few in number and were made on a line 50 ft. south of the actual line of the tunnel it was not at all certain that the tunnel might not strike a projecting ledge of this rock if it were located too low.

On the whole, therefore, it was determined to steer as nearly as possible midway between the Scylla and Charybydis thus presented, and a location was chosen which left a layer of clay above and below the tunnel about 12 ft. thick on the average, although at one point the top of the tunnel is but 8 ft. below the top of the clay and the bottom of the tunnel approaches within 10 ft. of the rock.

To provide for drainage the portion of the tunnel beneath the river was given a gradient of $\frac{1}{10}$% toward the Canadian side, where a pump shaft was located. The approaches both in open cut and in the tunnel were given a grade of 2%. The depression of the lowest point of the tunnel below the level of the railway beyond the approaches is 100 ft.

SINKING ENTRANCE SHAFTS.

The plan now proposed for carrying on the work was to sink a shaft on each bank of the river on the center line of the tunnel. From the bottom of each shaft the tunnel would then be driven beneath the river. Thus the most difficult part of the work would be accomplished first; and if that could not be carried out, no expenditures need be made on the land portions of the tunnel.

The shaft on the American side was sunk 58 ft. and the one on the Canadian side 90 ft., by means of rapid work and liberal use of pumps. Here the material became so soft that it rose in the middle of the shaft faster than it could be excavated, and although the Canadian shaft was down within a few feet of the tunnel level, the work in the shafts was abandoned and they were filled up.

A SUCCESSFUL PLAN AT LAST.

The difficulties encountered in these shafts and in the drift proved conclusively that no ordinary method of tunneling would be successful, and another consultation was had as to the best method of proceeding with the work. President Sir HENRY TYLER came over from England, and plans were carefully discussed and settled for carrying the work through. It was decided to excavate an open cutting at each end at the point where it was intended to place the tunnel portal, and to begin the excavation of the tunnel here. It was also decided to carry on the excavation by the use of a shield and to line the tunnel with cast iron.

By this time, as might be expected, the work had acquired a very bad name among contractors. The memory of the losses on the Detroit river tunnel, as well as the total failure which had thus far attended the attempts at preliminary work at the St. Clair, was ample to persuade men that there was too much to be risked for the chances of gain in taking a contract to drive a tunnel beneath the St. Clair. It was evident that even if a contractor could be secured who would undertake the work, he would have to be paid a very large sum above the actual cost to reimburse him for his risk. The company concluded, therefore, to carry on the work without letting contracts.

Work was begun on excavating the pit at each tunnel portal in January, 1889. On the Canadian side the bottom of the tunnel is 60 ft. below the natural surface of the ground at the portal, and on the American side 52 ft. Tunneling began on the American side July 11, 1889. On the Canadian side the treacherous clay on the west slope of the open cutting slid down after the excavation was nearly completed and this so delayed the progress of the work that tunneling did not begin until Sept. 24.

The Electric Magnetic Reciprocating Engine.*

BY CHARLES J. VAN DEPOELE.

One of the recent developments in the electric line is the perfection of a new electric magnetic reciprocating engine.

For years past, and, indeed, ever since electricity was first used to magnetize an iron bar by means of a coil of wire, the idea of producing a reciprocating motion by the electric current has been entertained, and many unsuccessful attempts have been made to construct and operate such machines.

It is a well-known fact that when a current is made to flow through a coil of copper wire, or what may be termed a solenoid, a bar of iron placed near the ends of such a coil will be sucked into the solenoid, and the moment the current is broken the plunger or iron bar will be dropped by its own weight, or may be expelled by means of springs if the machine is in any other position than vertical. This principle, however beautiful, could never be successfully applied in the construction of heavy machinery on account of the make and break of the circuit, which has to take place in order to produce the pulsations of the current which causes the pulling and letting go of the plunger.

Not until the invention and construction by the writer of an electric generator which would give currents rising and falling at a definite speed could the current be sent to the coils of a reciprocating engine, there alternately attracting and repelling its plunger. In this apparatus, however, as will be seen later on, the rising and falling of the current is produced in such a way that it is absolutely certain that no spark is produced either in the machine or in the generator producing the current. The current is caused to rise and fall in closed circuits, and actuates the plunger of the reciprocating engine with a speed corresponding absolutely to the speed of the defined rise and fall of currents produced by the generator. Thus, the generator can be caused to produce, say, 400 pulsations of current a minute, or it can be made to produce either a higher or lower number than this, so that the engine's speed can be regulated according to the size of its piston and the work it has to do.

The engine itself is a simple piece of machinery, consisting of two or more coils of copper wire, or solenoids, incased in an iron envelope protecting them from outside injury. Within these coils is placed a brass tube, and within this an iron plunger, capable of moving to and fro under the action of the currents in the coils. To the end of this iron plunger is attached a piston rod, similar to that of an ordinary engine, and to this is attached the hammer, drill or whatever tool is to be operated by the engine.

A very simple means of connecting the reciprocating

* Extracted from a paper by H. C. Spaulding, presented at the New York meeting of the American Institute of Mining Engineers.

engine to the current is applied to the machine, so that it can be stopped and started instantly. The cables leading from the generating station to where the current is to be used are perfectly insulated in the usual manner, and switch boxes are disposed along the main cables. From these, flexible cables are led to the reciprocating machine, so that it can be moved, if necessary, from one place to another, without any trouble whatever. The cable is incased in a rubber tube to protect it from injury and to prevent loss of current by contact with the ground.

It will readily be seen that one of the first applications of these machines will be to rock drills, such as are now in use in nearly all mining and rock work, for quarrying, prospecting, etc. The simplicity of the machine lends itself most readily to this application, as it will be seen that there are no movable parts on the whole machine except the plunger and piston rod carrying the tool.

There are no valves, as in steam engines, no switches, no make and break of the circuit, and no exposed current-carrying parts, so that the whole can be handled with safety and without any skill above that of common laborers. By turning on the switch the machine is started; by turning off the current, it is stopped. There is absolutely nothing to be done to the machine, except occasionally to pour in a few drops of oil, to lubricate the piston and its rod.

For ordinary mining work the drill is mounted on a tripod similar to that now in use with the steam and air drills which are well known to-day, or it can be attached to horizontal bars or to vertical columns; in fact, it lends itself to absolutely the same work as has been done heretofore by the air and steam drills. It will work in any position, from horizontal to vertical. The weight of these drills will be approximately the same as that of the steam or air drills of the same capacity, and everything is so arranged that the men accustomed to work the latter machines will find no difficulty in operating the new electric drills.

The apparatus for generating currents to operate these drills or electro-magnetic engines can be placed at any distance from where the drills are at work, and any number of drills can be worked from the same source, each drill working independently of the other, and whether one or more are in operation, the generator will regulate and furnish a current exactly proportional to the demand.

Where a long distance exists between the generator and the place where the current is to be distributed, a system of conversion is used; that is, the current is changed from a high to a low potential, so that the primary current, transmitting the power from the prime motor, can be of a high tension. Since this current could be guarded against possible contact, there would be no danger in using high voltage. At the point of application, the high potential is converted to a low potential of such pressure only as may be found desirable and practicable. Where the distance is, say, only one or two miles, it will not be necessary to use any system of conversion whatever, as a current of suitable potential can be run directly from the generator to the mines.

The main advantage, however, is the superior economy over the motors now in use where steam or air is to be conveyed to a distance of only a few hundred feet. There is an enormous loss in this transmission, and methods of steam or air transmission are certainly very limited in scope. There is, also, the trouble of leakage, making a system of piping much more costly in maintenance; but this is done away with when electricity is employed. All parts are so simple that they will require little or no repair for very long terms; and such repairs as will have to be made will always be much less expensive than in the case of steam or air driven machines.

A New Fire Hydrant.

We show in the accompanying illustrations an admirable new hydrant lately introduced by the Eddy Valve Co., of Waterford, N. Y. It embodies a number of important new features which would appear to make it one of the most complete hydrants now before the public. The main features of the device may be described as follows:

The lower end of the valve stem, *S*, which is of brass, works in a post in the bottom of the hydrant, which is brass bushed, hence the valve is drawn instead of pushed down to its seat, and for this reason it cannot be moved, nor can any water escape should the stand pipe become broken.

The brass valve seat *N* is made only slightly tapering, but at such an angle as to impede foreign substances from lodging upon it. The rubber-faced valve *V* is made on the same taper and adjusts itself to it. The rubber is so attached to the valve that it can easily be removed and another substituted. In fact, one of the neatest things about the hydrant is the accessibility of all parts of it for renewals or repairs. Every moving part can be examined and replaced with ease.

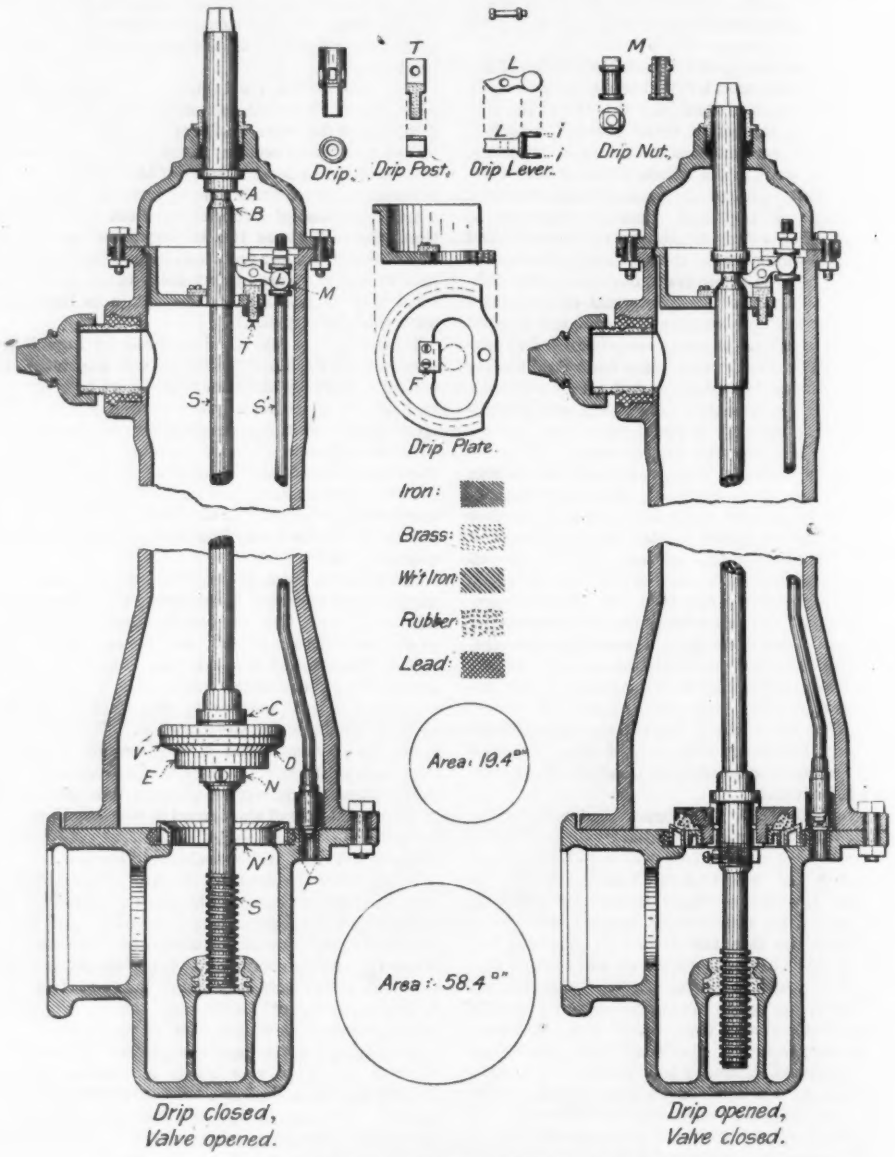
The valve is made with a straight cylinder piece *E*, which is the first to enter the valve opening as the valve is being closed. Thus it gradually closes off the area of the valve opening, so that but little water is passing through it when the face of the valve is still quite a distance from the valve seat. In this way the tendency to any "water ram" action is greatly reduced and practically eliminated.

When the rubber face of the valve is brought to a bearing on the valve seat it does not revolve, being loose on the stem, but the motion of the stem continues, revolving in the center of the valve. The collar, turning and seating on a brass bush in the valve, prevents twisting or tearing of the rubber.

By removing the check nut *N*, the valve can be taken off the stem, and as all parts of the hydrant drip plug sufficiently to allow the water in the stand pipe to escape. When the valve is raised the lower edge *B* of the groove on the valve stem strikes the drip lever and forces the drip plug down into the cup, thereby both closing and opening the apertures by positive motion, and also positively holding either open or closed between times.

This drip is adjustable as to the throw and the pressure which forces the plug into the drip cup. As less than one revolution of the stem operates the drip, practically no water is wasted beyond the small amount necessary to fill the hydrant barrel once.

Furthermore, the drip plug and rod can be removed while the pressure is on the valve, and can



NEW FIRE HYDRANT, EDDY VALVE CO.

are interchangeable, any piece can be replaced without trouble and with slight expense.

The rising and lowering of the stem in working the valve serves as an indicator to show the position of the valve, and the collar near the top of the stem *A*, on coming in contact with the top of the cover, limits its rise and prevents the screw from turning out of the bottom post.

If at any time it is desirable to flush the mains, all internal parts of the hydrant can be removed through the stand pipe, and all obstructions that can pass through the valve opening will be forced up and out of it.

The drip *P*, located at the side of the valve seat, drains the stand pipe perfectly through apertures in the side of the brass drip cup. In this cup a solid rubber plug or plunger is inserted which opens and closes the drip. This plug or plunger is attached to the end of the drip rod *S'*, and when the hydrant valve is nearly to its seat (within a revolution), the upper surface *A* of the groove *B* in the main stem strikes the end of the drip operating lever *L* and raises the

be adjusted from the top without being taken from the stand pipe. In case the hydrant is set in wet soil, and it is desirable to have the drip permanently closed or sealed, the dog at the top of the drip rod can be removed and a simple device attached to hold the rod down in position.

It will be seen that there is practically no wear on the working parts of this hydrant, and that the cost of repairs should be almost nominal. From actual tests with pressure gauges it is stated that there is less than 2 per cent. loss in friction from water passing through and out of stand pipe; a remarkably good record. Why it should be good will be at once seen from the drawings. The water is almost unimpeded in its passage when the valve is open.

These hydrants are made for pipe connections ranging from 3 ins. to 10 ins., with stand pipes ranging from 4½ to 9¾ ins. interior diameter, and 3 to 8 ins. valve seat ring, with from one to six 2½ in. nozzles, and with steamer nozzles and frost cases as ordered. The standard length of hydrant from pavement to bottom of connecting pipe is 5 ft.

The Steel Armor Tests at Annapolis.

Supplementing the account in our last issue of these notable tests, we give herewith a cut showing the manner of mounting the plates and backing, and also engravings from photographs showing the actual status of each plate after the four 6-in. shots had been fired at each and after a fifth shot from an 8-in. gun had been fired at them. For the photographs and also for the following fuller and more precise details of the effect of each shot (which we reproduce as such, although in part repeating details given last week) we are indebted to Ensigns R. B. DASHIELL and R. F. LOPEZ, U. S. N.

The three plates tested were (1) an all-steel plate and (2) a nickel-steel (5% of nickel) plate, furnished by Schneider & Co., of Le Creusot, France, and (3) a compound plate, Wilson patent (one-third its thickness hard steel, backed by wrought iron), furnished by Cammell & Co., of Sheffield, England.

The plates were 10⅛ ins. thick*, 8 ft. long and 6 ft. wide. They were bolted to an oak backing 38 ins. thick, supported by a strong oak bracing, as shown in the accompanying cut. The plates were also supported on each side by wrought iron plates, as shown in cut, 10⅛ ins. thick, bolted to oak backing.

The Cammell plate was fastened to the backing by eight 4-in. bolts, and the Schneider plates by twelve 3¼-in. bolts. The bolts screwed into back of plates about 4 ins.

The board conducting the tests was composed of Rear-Admiral L. A. KIMBERLY, President; Capt. E. O. MATHEWS; Commander W. R. BRIDGMAN; Lieut.-Commander W. MAYNARD; Lieutenants J. F. MEIGS, B. H. BUCKINGHAM, A. MCCRACKIN, F. F. FLETCHER; Ensigns P. R. ALGER, A. A. ACKERMAN and R. B. DASHIELL.

On Sept. 18 the 6-in. breech-loading rifled gun made at Washington Navy Yard specially for the tests (in 52 days) was used.

Length, 35 caliber.	Weight of projectile, 100 lbs.
Powder, brown prismatic.	Initial velocity, 2,075 f. s.
Charge of do., 44½ lbs.	Muzzle energy, 2,988 ft.-tons.
Projectiles, Holtzer chrome steel, 17 ins. long.	Distance target from muzzle, 28 ft. 11 in.

SHOTS AT ALL-STEEL PLATE.

Round 1.—Projectile stuck in plate apparently intact, penetrating 10¼ ins., base projecting 6¾ ins. Bulge raised 17½ ins. in diameter, 1 in. high, surmounted by fringe 1 in. high; 6 short radial fissures started.

Round 4.—Projectile penetrated 12⅛ ins. and rebounded unbroken. Bulge raised 18 ins. in diameter, 1 in. high; 8 short radial cracks developed.

Round 7.—Same results in all respects as Round 4, except that there were only 5 short radial fissures.

Round 10.—Same penetration as Rounds 4 and 7; projectile rebounded broken, apparently somewhat defective; bulge 17 ins. in diameter, 1 in. high, surmounted by 1 in. fringe; 6 short radial fissures.

SHOTS AT NICKEL-STEEL PLATE.

Round 3.—Projectile broke off, point remaining in plate. Penetration not precisely given, can be judged from cuts. Bulge 17 ins. in diameter and 1¼ ins. high; 2 radial and 1 circular crack.

Round 6.—Projectile penetrated 15 ins. and stuck in plate apparently intact. Bulge 16 ins. in diameter and 1¼ ins. high. Fragments of metal broken off around hole, forming an irregular figure of 12⅛ ins. maximum diameter and 1¼ ins. deep.

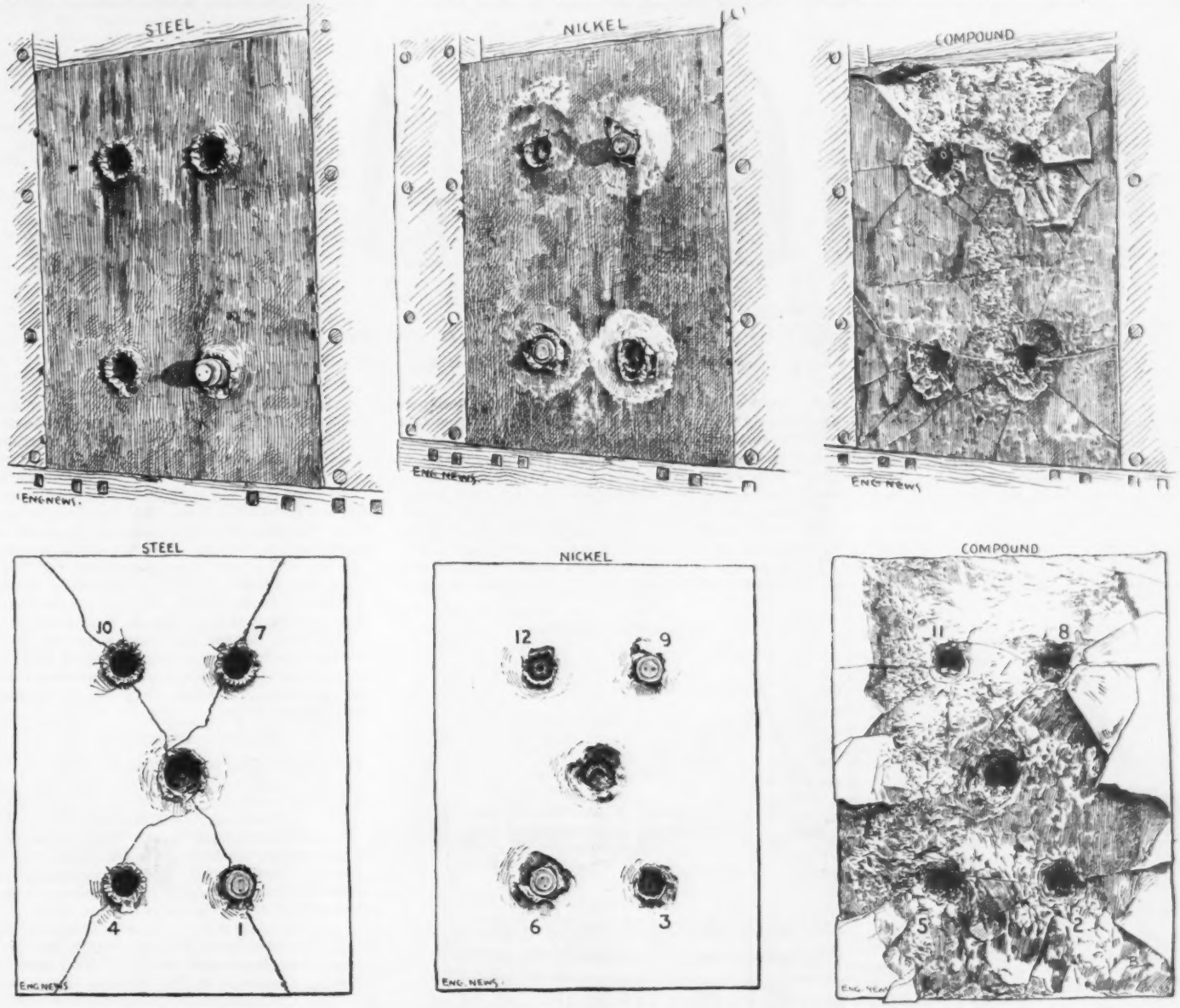
Round 9.—Projectile penetrated 12⅛ ins., projecting 4⅛ ins., apparently intact. Bulge 18 ins. in diameter and 1¼ ins. high; 2 short radial fissures.

Round 12.—Projectile broke off, point remaining in plate; break 3⅛ ins. in from face of plate. Bulge 16 ins. in diameter and 1 in. high; 1 small fissure.

SHOTS AT COMPOUND STEEL AND IRON PLATES.

Round 2.—Projectile penetrated 21⅛ ins., hole 6¼ ins. wide. Small fragments broken off around shot hole, forming an irregular figure varying from 14½ to 19 ins. in diameter, and 1½ to 2 ins. deep; 8 long radial cracks, 24 to 55 ins. in length, one extending to right-hand edge of plate.

Round 5.—Projectile penetrated 25½ ins. Steel face scaled off around shot hole, forming an irregular figure about 14 ins. diameter and 1 in. deep; 6 long radial cracks, all extending to edge of plate; horizontal surface crack formed about 12 ins. above the two shot holes and extending nearly across plate



STEEL ARMOR PLATES AFTER TESTS AT ANNAPOLIS, MD.

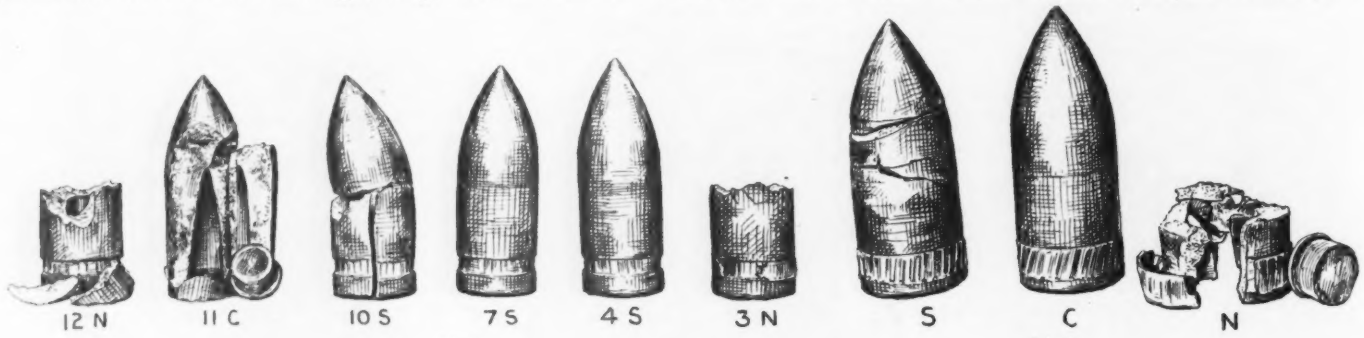
The numbers on lower views show order of rounds from 6-in. gun. The three upper views show actual appearance of plates after first twelve rounds. In the three lower views only the parts affected by shots are shaded.

*By an error in rolling the Cammell plate was 10.6 instead of 10.5 ins. thick.

In this and the following rounds the cracks developed by previous rounds were increased in size.

Round 8.—Projectile penetrated 34½ ins.; 10 deep radial fissures formed; a large piece of steel face in upper right-hand corner slightly separated from backing.

Round 11.—Projectile perforated both plate and backing; 3 through cracks developed; all the steel face above this and the preceding shot hole scaled off the backing; 7 pieces weighing from 30 to 380 lbs. thrown off; a part of the steel face below the previous shot hole broke off from the backing; backing



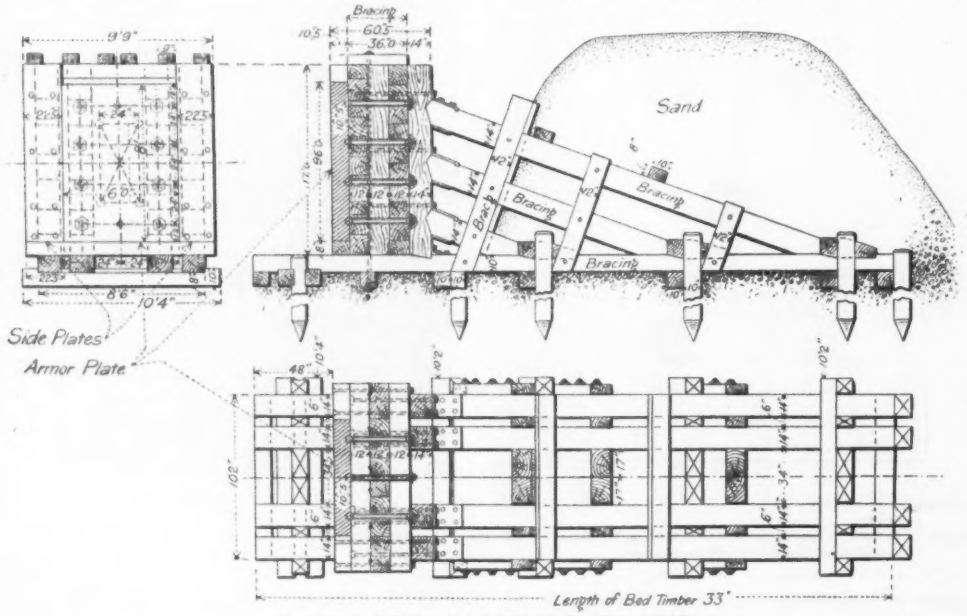
PROJECTILES USED IN TESTING ARMOR PLATES AT ANNAPOLIS, MD.

Numbers refer to rounds from 6-in. gun. Letters indicate plate at which projectile was fired: S, all steel; N, nickel steel; C, compound.

showed a rough appearance with a number of small cracks running across it. There were now 17 large cracks running through the steel face.

This finished the test with the 6-in. gun. On Sept. 22 the 8-in. breech-loading rifle made at Washington Navy Yard was used, one shot being fired at the center of each plate:

Projectile, Firth.	Initial velocity, 1,850 f. s.
Wt. of projectile, 210 lbs.	Muzzle energy, 4,988 ft.-tons.
Powder, brown prismatic.	Dist. of target from muzzle = 30 ft. 11 ins.
Charge, 85 lbs.	



BACKING USED IN ARMOR PLATE TESTS.

1*st* 8-*in. Round; All-Steel Plate.*—The projectile penetrated 15 ins. raising a bulge 21 ins. in diameter and 1 in. high; 4 through radial cracks developed from short hole, 2 above and 2 below, each extending diagonally through the 6-in. shot holes to top and bottom of plate. The cracks were about ⅛ in. wide. A piece of metal was scaled off around shot hole.

2*d* 8-*in. Round; Nickel Plate.*—The projectile penetrated and broke off, the head remaining in plate, the distance from face of plate to broken part being 5 ins. A bulge 16.5 ins. in diameter and 1 in. high was raised around shot hole. Metal scaled off around hole.

3*d* 8-*in. Round; Compound Plate.*—The projectile perforated plate and backing. Most of steel face scaled off. Condition of plate best shown in photograph.

quite different. The tests seem to have been perfectly fair so far as they go; but it is not reasonable to base such important conclusions upon a single test, however carefully made. The compound plate, with which many ships of the British navy are armored, may be considered as out of the game, but as between the other two plates there was not difference enough developed to make it wise to accept the result as conclusive. More all-steel plates of the same and of different makes should be tested, and also at least one more nickel plate before the result can be considered certain. Individual plates of the same make and composition might well differ as much as the two steel plates in these tests.

This finished the tests. As a result, Congress has already passed a joint resolution appropriating $1,000,000 to enable the Secretary of the Navy to purchase nickel ore and nickel matte for the use of the navy; which is well. Nevertheless, as we said last week, it is not wise to regard the case as concluded in favor of nickel-steel. Further tests, including especially tests of heavier projectiles fired at considerably greater range or (what is the same thing in effect) with lower muzzle velocities, are highly desirable. Even if the energy of the blow in foot tons remained the same, the effect might be

The Mining and Metallurgical Engineers of Three Nations.

The most important engineering meeting of the year has been in session in New York City during the past week. The American Institute of Mining Engineers, the Iron and Steel Institute of Great Britain, and the *Verein Deutscher Eisenhuettenleute* of Germany have held a "joint and several" convention here. "Joint" since the meetings and excursions have been attended by members of all the three societies, and "several" since the formal sessions have been held partly as sessions of one body and partly as sessions of another.

The Iron and Steel Institute, which was organized 21 years ago, includes the principal iron masters and metallurgists of Great Britain. The *Verein Deutscher Eisenhuettenleute*, although one of the youngest of German technical societies, has a membership of nearly 1,000, composed principally of mining engineers and metallurgists. The American Society needs no description in these columns.

Among the more distinguished of the foreign visitors are: Sir JAMES KITSON, President, and Sir LOWTHIAN BELL, Past-President of the Iron and Steel Institute; Sir JOHN G. N. ALLEYNE, Messrs. P. C. GILCHRIST, EDWARD P. MARTIN, E. WINDSOR RICHARDS, G. J. SNELUS, F. R. S., and WM. WHITWELL, Vice-Presidents and members of Council of the Iron and Steel Institute; E. SCHROEDTER, Secretary, and H. BRAUNS, First Vice-President, of the *Verein Deutscher Eisenhuettenleute*; E. BLASS, R. M. DAELEN and A. THIELEN, Directors of that society.

Among other prominent guests are Sir WM. ARROL, JAS. DREDGE, Editor of *Engineering*, R. A. HADFIELD, THEODORE FRY, M. P.; Sir JAS. BAIN, FELIX BISCHOFF, WM DAVIES, M. H. GRAZEBROOK, JAS. LIVESEY, ROBERT MANNESMAN, and Sir THOS. STOREY. The total number of members of both the foreign societies registered at headquarters is between five and six hundred, which number includes nearly seventy ladies.

MONDAY AFTERNOON.

The first session of the meeting was that of the American Institute of Mining Engineers, and was called to order at 2:30 P. M., Sept. 29, in Chickering Hall, by the President, Hon. ABRAM S. HEWITT. Mr. J. F. LEWIS, chairman of the local committee, briefly welcomed the Institute and its guests to New York City. The long list of announcements of the various excursions tendered the members of the three societies during their stay in New York was read, and President HEWITT remarked that this list was good proof of the fidelity with which the local committee had performed its work. He joined in extending a welcome to the societies, saying that New York City's growth and prosperity were chiefly due to the achievements of men of science.

Secretary ROSITTER W. RAYMOND read the list of applicants for membership in the society, of which there were no less than 82, showing a very prosperous condition of affairs. The applicants were duly elected. The Secretary announced that the usual February meeting of the Institute will be omitted.

The reading of papers was then begun, the first on the list being a paper by Mr. JAS. C. BAYLES on "Explosions from Unknown Causes." The most unsatisfactory occurrences in a manufacturing business, said the author, are those by which the owner suffers damage and at the same time learns nothing useful. It is some consolation, in the event of an accident, to know the cause and think that it might have been worse.

The author then described three explosions which had recently occurred under his notice, for which no satisfactory explanation had been found. All three explosions were evidently due to the ignition of a mixture of gas and air. The first occurred at a dead end in a 16-in. air pipe; in the second a Sturtevant blower disappeared in the twinkling of an eye, and in the third two of the boxes in a gas purifier containing sesqui-oxide of iron were wrecked.

In each case the author explained that what seemed to be the only reasonable hypothesis as to how the explosive mixture of air and gas came to be present, and how it came to be ignited, was not reasonable at all. He invited any one to furnish a better explanation, but no one accepted the challenge.

The following four papers, which were read by title and not discussed, related to the use of electro-magnets for concentrating iron ores, a process which has now passed from the domain of experiment to one of the important methods of practical metallurgy.

The paper by CLEMENS JONES, Hokendauqua, Pa., was on the magnetization of iron ore. The author described a process by which hydrous oxides of iron, especially brown hematite, can be made magnetic, so that they can be treated in a magnetic concentrator. Brown hematite ore has been the material from which a great part of the iron made in this country has been extracted. At present a great many of the old beds have been abandoned because of the difficulty of concentration. The author has found that heating brown hematite in the presence of carbon or carbon dioxide renders it magnetic and suitable for treatment in a concentrator. The cost of the process is estimated in the following extract from the paper:

The commercial success of treating ores in this way depends on the three items—cost of wash-ore, cost of roasting, cost of concentration. The first may be considered to range from 75 cts. to $1.50 per ton, according to locality. The second item will be fully covered by the following statement, taken from the books of a large company exclusively engaged in roasting carbonate ores, and at that time under the most capable management.

ACTUAL COST PER TON OF ROASTING AND HANDLING ORE.

Roasting Ore.

	1886.	1887.	1888.
Labor, including car and top man	$0.0083	$0.0073	$0.0811
Supplies	0.0024	0.0032	0.0091
Coal	0.0725	0.0750	0.0748
	$0.1632	$0.1455	$0.1650
Culm, per ton	2.00	2.10	2.25
Average cost			$0.1600

About 1 ton of culm used to 30 tons of ore.

Handling and Wharf Expenses.

	1886.	1887.	1888.
Labor, including engineer and teamster	$0.0514	$0.0439	$0.0720
Supplies and coal	0.0177	0.0132	0.0169
Team		0.0040	0.0062
Repairs, etc	0.0046	0.0025	0.0029
	$0.0731	$0.0636	$0.0980
Average			$0.0700
Average total cost			0.2300

Per ton of ore treated.

The third item remains to be determined—namely, the cost of concentration, including royalty on the process. This would be 2 cts. per ton for concentrating and 25 cts. royalty. Taking as an example an ore having 33.5% iron in the crude ore, the cost of the concentrated ore would be as follows:

Cost of 1½ tons ore	$2.22
" roasting	36
" concentration and royalty	27
	$2.88

At a yield of 48% iron, this is 6 cts. a unit, or, in round numbers, $6 to the ton of iron.

The second paper was by Mr. JOHN C. FOWLE, and described the process of magnetic concentration as practiced at the Michigamme iron mine in the North Michigan peninsula. The operating plant in use here includes one 15-in. Wenstrom separator and one 36-in. Buchanan separator. The results are very satisfactory, but the author considers magnetic separators to be still in their infancy as regards cost, capacity and quality of product.

The next paper, by Mr. E. F. MCDOWELL, was similar in its nature, describing the excellent results obtained with a Conkling magnetic separator at the Tilly Foster mine. We reprint the paper in full in another column. A description of the Tilly Foster mine may be found in ENGINEERING NEWS of April 20, 1889.

The last paper presented at this session was by Mr. C. M. BALL, of Troy, N. Y., describing the "Monarch" magnetic separator, invented by the author in conjunction with Mr. SHELDON NORTON, of Hokendauqua, Pa. A working model of the machine was exhibited and was examined with great interest by the members. The feats performed by this machine in obtaining from iron ore containing high percentages of phosphorus, concentrates equal to the best Bessemer ore are most remarkable. The greatest performance yet recorded for the machine was to convert Port Henry old bed ore having 2.25% of P_2O into a Bessemer ore carrying Fe 71.10%, P. .037%. The results of other tests are given in the following table:

MINE.	Crude ore		Con'trates.		Tailings.
	Fe.	P.	Fe.	P.	Per cent. of original weight.
Chateaugay tailings	11.80	.....	68.365	0.008	89.0
Port Henry, New Bed	.....	.....	70.9	0.0089	38.0
" Old Bed, 21	58.70	2.25	71.1	0.037	20.0
Croton, N.Y., ore	42.99	0.153	69.86	0.021	47.0

The Chateaugay tailings contained but 4.33% Fe after the concentrate was removed, and the tailing from the Croton ore, 7.95% Fe.

MONDAY EVENING.

An audience numbering over 300 were assembled in Chickering Hall when Vice-President ECKLEY B. COXE called the assembly to order. Secretary Raymond announced that the paper by OBERLIN SMITH on cast-iron tools for cutting metals, which was postponed from the afternoon, would not be presented at this meeting; but would be printed and distributed later.

Prof. W. B. POTTER, of St. Louis, was then introduced, and gave a most interesting description of the mines at Iron Mountain, Mo., illustrating his lecture by numerous lantern views, showing the geological structure of the ore deposit and the rock associated with it, with the methods of mining and working the ore. Iron Mountain is about 80 miles south of St. Louis, and has been one of the most famous of American iron ore deposits. Most of the ore has been taken from a great vein by an open cut 150 ft. deep, and over 1,000 ft. in length, from which over 3,500,000 tons of ore have been taken.

The geologic structure of the deposit is quite peculiar. One vein, from which an enormous amount of ore has been taken, consists of lumps of ore from the size of a barrel down to fine sand cemented together by clay. This vein is the detritus from a former mountain of ore which in past geologic ages slowly accumulated in the ravines on its slope. This deposit is now overlaid by over 100 ft. of limestones and sandstones.

Describing the machinery used, the speaker mentioned a new drill invented by Mr. SYPHER, foreman of the company's repair shop, which has been in use for two years, and has given better satisfaction than any drill ever used there.

Practically all the machinery, drills, pumps, hoists, inclines, etc., is worked by compressed air, which is delivered from a central station through a line of old pipe formerly used for a hydraulic force main.

The hydraulic method of treating ore, which is in some respects similiar to the hydraulic system of gold mining, is largely used here. Water is pumped up to storage reservoirs 360 ft. above the supply pond, and descends to the workings under a head of 150 ft. By the use of a stream under this head a pile of ore can be "turned over," and made marketable at a minimum expense. Crushers have just been put in here, and are giving great satisfaction. The results indicate that it will be possible to crush ore at a cost of 5 cts. per ton in regular work.

By the methods of assorting used, a Bessemer ore can be obtained having as low as two or three thousandths of 1% of phosphorus or (if any one desires) an ore with two or three per cent. of phosphorus can be furnished.

A paper on "American and Foreign Practice with the Diamond Drill," also illustrated by lantern views, was read by Mr. W. F. DURFEE, of Birdsboro, Pa., who said, that as the hour was late and his paper was a technical one, he expected to prove to the complete satisfaction of the audience, by the time he had finished, the efficiency of the diamond drill as a boring machine. In this attempt Mr. DURFEE failed and succeeded at the same time, a feat not often recorded.

Percussive drills, similar in principle to the American oil-well drill, were used in China centuries ago, holes being bored 1,500 to 1,800 ft. deep with tools suspended by a rope. The first diamond drill was invented by a Frenchman, Prof. RODOLPH LESCHOT, in 1862; and, though very crude, it had the hollow bit and core lifter, which are the cardinal features of the diamond drill.

In this connection the author described the curious invention of an Englishman, JAS. MURDOCH, an assistant of JAS. WATT, who proposed to make stone water mains by boring out a core with an annular bit from a cylindrical block of stone. The bit used was of soft iron and was fed with sand as it rotated. The first pipes for the public water supply of Manchester, England, were made by this process. They were made in 2 ft. lengths, 3 to 18 ins. in diameter, joined by a hub and spigot joint, made tight with Roman cement; and, as might have been expected, they failed at once under pressure, and were replaced with cast-iron mains.

Coming down to the modern diamond drills, the author said that the speed and cost of diamond drilling depended on the depth of the hole, the hardness of the rock, etc. A fair average as to speed was 100 ft. per week, and as to cost, $2.50 to $4.00 per ft. Drills under test have run 1 ft. per minute in sandstone, and 22 ins. per minute in anthracite coal. The diamonds used are the black Brazilian diamonds, worthless as ornaments, but so valuable in mechanical processes that they are worth $10 to $13 per carat.

In conclusion the author stated that recent discoveries in Egypt had made it almost certain that the diamond drill or diamond saw was known and used by the ancient Egyptians.

TUESDAY MORNING.

The first paper on the list for this session was by H. H. CAMPBELL, of the Pennsylvania Steel Company, Steelton, Pa., on "The Physical and Chemical Equations of the Open Hearth Process;" and was read only by title and not discussed. The paper was a voluminous monograph, dealing with theoretical matters in its methods, of necessity, but showing results of much practical value.

The second paper presented was one of the most general interest to the members of the whole list. It was by Mr. H. C. SPAULDING, of Boston, on Electric Power-Transmission in Mining Operations. The author described briefly the rapid growth of electricity in mining work. It is now applied to diamond drills, reciprocating drills, under-cutting machines for coal mining, locomotives for hauling, hoists, pumps, and of course for giving light in all the underground workings. The most interesting and novel of these machines is the electric reciprocating drill, in which, by the use of a pulsating current, the drill is reciprocated directly by the magnetic action of the electric current, the sole moving part of the mechanism being the drill and drill shaft. Two companies have almost simultaneously brought out this invention; and one, the Thomson-Houston Company, is already erecting a large factory, to be especially devoted to electric drilling and pumping machinery of the reciprocating type.

We publish elsewhere the description of the Van Depoele drill, written by its inventor, which formed part of Mr. SPAULDING'S paper.

In the discussion upon this paper the advantages of the alternating current for distributing power over long distance were clearly brought out. The secretary announced that after the long excursions to the South and Northwest were concluded, the Thomson-Houston Co. proposed to organize another excursion, and take a party of the foreigners to visit some of the principal electrical plants of the country.

The other papers presented at the morning session were read only by title, and were not discussed. They were "Amalgamation at the Comstock Lode, Nevada," by A. D. HODGES, Jr., of Boston, and "Notes on the Excavation of the New Croton Aqueduct" by J. P. CARSON, of New York City. The latter described the features in connection with the construction of this tunnel of most interest to mining engineers. A paper by J. POHLIG, of Cologne, Germany, on "Wire Rope Tramways" was called for; but as the steamer which carried both Mr. POHLIG and the paper had not yet arrived in New York harbor, the discussion was postponed. Models of the apparatus described by Mr. POHLIG will be shown next week at Pittsburg. A paper by E. BLASS, of Essen, Germany, was also postponed, and adjournment was then taken.

TUESDAY AFTERNOON.

Perhaps the long list of papers set down for consideration at this session frightened the members away; at any rate, the attendance was rather small considering the number of members of the three societies in the city. They need not have stayed away on account of the length of the programme, however, as the hour and a half session was spent in considering two papers only.

The first paper to be read by one of the visiting foreigners before the American Society was on "Recent Improvements in German Steel Works and Rolling Mills" by R. M. DAELEN, of Duesseldorf, Germany. The author said that the improvements introduced in recent years indicated that ingot-iron was soon to replace the product of the puddling furnaces for almost every purpose. Large works at present aim to convert the molten blast-furnace pig into a finished product without reheating it at any point. The nearest approximation to this now practiced is to take an ingot from the soaking pit and run it continuously through the rolls, using only one reheating furnace, and that for but a short time. The ingot is 15 ins. in diameter and makes a four-length rail.

Regarding the basic process, he said that small basic Bessemer converters were not favored; while small basic reverberatory furnaces were fast increasing.

The feature of Mr. DAELEN'S paper which excited most interest was that relating to the use of soaking pits; and Messrs. HOWE, HUNT, WELLMAN and HOLLOWAY of the American members quizzed the author very closely as to the advantages of the plain pit over the gas-fired pit, which is used in America where soaking pits are used at all. The loss by oxidation in the plain pit was given by Mr. DAELEN as only 1%, but Mr. HOWE said that American gas-fired pits were worked with no higher percentage of oxidation. Mr. DURFEE, however, assisted Mr. DAELEN in defending the plain pit, and said that the new plant of the Pennsylvania Steel Co. at Sparrows Point, Md., would use the plain pit. It developed finally that success with plain pits depended on their being located close to the converters and set low enough to prevent cold tops on the ingots.

The paper on "American Rolling Mills," by R. W. HUNT, was postponed, and a paper on "Machinery for Charging and Heating Melting Furnaces," by S. T. WELLMAN, of Thurlow, Pa., was read, the author prefacing the reading by saying that if the soaking pit was to come into general use, there might be no need of the crane for charging ingots in reheating furnaces, which the first part of his paper described. Machines of the type described by Mr. WELLMAN have just been put in use at the Homestead Works, the Otis Works at Cleveland and the South Works of the Illinois Steel Co.

The remaining papers, which were read by title, were as follows: "A Suspended Feed Table for Rolling Mills," by JAS. MORGAN, Pittsburg, Pa.; "Pneumatic Hoisting," by Prof. H. A. WHEELER, Washington University, St. Louis; "The Walker Anti-Vibration Regulating Shutter or Slide for Guibal or Other Inclosed Fans," by EDWARD R. WALKER, Weybridge, England; "The Department of Metallurgy and Economic Geology in the National Museum," by F. P. DEWEY, Washington, D. C.; "Notes on Coal Mining in Oregon," by R. H. NORTON, Portland, Ore.; "The Resources of the Black Hills and Big Horn Country, Wyoming," by H. M. CHANCE, Philadelphia, Pa.; "The Potosi, Bolivia, Silver District," by ARTHUR F. WENDT, New York City; "The Pratt Mines of the Tennessee Coal, Iron & R. R. Co.," by ERSKINE RAMSEY, Pratt Mines, Ala.; "The Paint Mines of Lehigh Gap, Pa.," by C. E. HESSE, Bethlehem, Pa.; "Methods and Apparatus for Boring and Operating Oil Wells," by J. C. BOYCE, Pittsburg, Pa.

TUESDAY EVENING.

Three speakers were announced to entertain and instruct the audience at the evening session, the first of whom was ALPHONSE FTELEY, Chief Engineer of the New Croton Aqueduct.

With the aid of the stereopticon, Mr. FTELEY described the general features of New York City's water supply, and the new aqueduct and great dams which are of such engineering interest. As good evidence of how far the city had outgrown the capacity of the old aqueduct, Mr. FTELEY said that since the new supply has been introduced and the pressure has been increased throughout the city the daily consumption per capita has jumped up from 110 galls. to 150 galls., or over 40,000,000 galls. per day increase. Mr. FTELEY wound up by stating that the total cost of the aqueduct had been nearly $20,000,000, and handed over the bamboo pointer to Mr. JAMES DOUGLAS, Jr., whose paper on "The Copper Resources of the United States," promised by its title to be as dry as Mr. FTELEY'S subject was interesting.

But the dryest subject, when treated by a man who is master of all its details, and who is full of enthusiasm concerning it, may be made to glow with life, and the dry facts and figures which Mr. DOUGLAS presented reached a pleased and interested audience. Of all the speakers who used the stereopticon his was the subject of least interest, and was treated with greatest success.

Opening with a quaint sketch of the early copper mining in the New World, the speaker rapidly outlined the growth of the lake region, Vershire, Vt., Ducktown, Tenn., California, Arizona and Montana, as copper producing fields. At the present time the Lake copper forms 34%, Montana copper 45%, and Arizona copper 12 to 13% of the total output of the United States. He believed that no more such great deposits as those of Lake Superior or Montana were likely to be found in the United States.

The growth of copper consumption has been most remarkable. In 1850 the United States used ½ lb. per capita. In 1860 the per capita consumption had decreased to 0.4 lb., due probably to the decreasing use of wooden ships with copper sheathing. In 1870, it rose to 0.7 lb. In 1880 it was 1 lb.; and in 1890 it was 2.7 lbs. per capita, the increase being largely due to the phenomenal demands by the electrical industries. In 1900 it is likely that the consumption of copper of the United States alone will equal that of the whole world at the present day. There need be no fear of scarcity, however, since enormous deposits of low grade ore are widely scattered in the West.

So much time was taken up by these two papers that Vice-President ECKLEY B. COXE, who had the concluding paper, describing the new iron coal breaker at Drifton, Pa., recently erected, forbore the formal presentation of the topic, and merely had the views showing the construction of the building flashed on the screen as fast as they could be put through the lantern.

THE IRON AND STEEL INSTITUTE—WEDNESDAY MORNING SESSION.

The sessions of the previous days had had a fair attendance, all things considered; but not until this morning, when the British Society took possession of Chickering Hall, was that commodious audience room well filled. In the President's chair sat Sir JAS. KITSON, a typical English gentleman in his appearance and manner. At his right was J. S. JEANS, the General Secretary of the Iron and Steel Institute, and on his left sat Sir LOWTHIAN BELL, looking every bit the scholarly scientist that he is.

President HEWITT was unfortunately prevented by illness from being present to deliver the annual address, but ANDREW CARNEGIE, chairman of the reception committee, welcomed most eloquently the visitors from abroad. In metallurgy, said he, we have little to show you save the development of the processes originated abroad. In civil and mechanical engineering, and especially in electrical engineering, in which we have had a fair chance with the older countries, we hope to show you some new departures. He concluded with a graceful tribute to the great benefits which American manufacturers and metallurgists owed to the scientific work of members of the Iron and Steel Institute.

President Sir JAMES KITSON, in a most polished address, replied to Mr. CARNEGIE'S speech of welcome. Alluding to the Past-President of the Institute, he said that Sir HENRY BESSEMER had hoped to take the trip to America, but his advanced age had rendered it impossible, and he sent a message expressing his regret. Alluding to Mr. CARNEGIE'S statement that this was an age of firsts, the President said: "We are met in the year when for the first time the United States has become the greatest pig-iron producing nation in the world. Mr. CARNEGIE, who welcomes us, is now the first producer of iron and steel in the world."

Reading then his formal presidential address, he described the growth of the Iron and Steel Institute and the progress of the inventions of BESSEMER, THOMAS, and GILCHRIST. Giving the history of the American iron trade he alluded to the Act of Parliament in 1750 suppressing the iron manufacture in the New England colonies, and said, "The rulers of my country were stupid, illiberal and grasping. We have grown wiser since that time and realize that in this wide world there is room for England, the United States and Germany. England has atoned for 1750 by pouring vast supplies of iron and steel into the United States to further its development. It is the wisest and most civilized nation which uses the greatest amount of iron and steel. The United States now consumes 310 lbs. per capita per annum, and England about 300 lbs. But the consumption per capita for the whole world in 1889 was but 14½ lbs., thus showing the great future possibilities of iron manufacture."

Following Sir JAMES KITSON'S address, Chairman LEWIS, of the local committee, and WM. P. SHINN, President of the American Society of Civil Engineers, and Chairman of the Committee on Transportation, made some announcements, in the midst of which Gen. SHERMAN was escorted upon the stage and was greeted with hearty applause by the visitors.

An invitation from the officers of the Province of Ontario and of the Canadian Covernment was presented, urging the members participating in the Northern excursion to visit the coal, iron and copper deposits of Canada. Mr. BLUE, Assistant Minister of Agriculture of Ontario, and Mr. SELWYN, of the Dominion Geological Survey, urged the acceptance of the invitation.

The routine business of the Institute was then disposed of, Sir FREDERICK ABEL being elected President, and ANDREW CARNEGIE, a member of the Council. The first technical paper, by JAS. GAYLEY, of Braddock, Pa., on "The Development of American Blast Furnaces with Special Reference to Large Yields," was then read. The notable feature of the paper was the enormous yield recorded for Furnace No. 7 of the EDGAR THOMSON Steel Works. Mr. GAYLEY closed by reading a telegram stating that for the 12 months ending at 6 A. M. Oct. 1, the furnace has made 113,526 tons of iron with a consumption of coke of 1,892 lbs. per ton of iron of 2,240 lbs. Hearty applause greeted this astounding record, and the President called on Sir LOWTHIAN BELL to open the discussion. Sir LOWTHIAN said that he would hardly have believed such remarkable production combined with such economy to be possible before he heard the paper. The output was *five times* that of the North Yorkshire furnaces and *twice* that of the best furnaces in all England using brown hematite ore. He believed the chief reason for the remarkable combination of great economy with enormous output was due to the excellent ore.

Mr. E. S. COOK, of Pottstown, gave figures of the production of American anthracite furnaces, showing that some of the best exceeded even the record of the Edgar Thomson in tons of iron produced per unit of capacity. A hasty adjournment was then taken, and both Americans and foreigners enjoyed a sail up the Hudson to the entrance of the Highlands.

THURSDAY MORNING.

Mr. R. M. DAELEN, of Duesseldorf, Germany, continued the discussion on Mr. GAYLEY'S paper, deprecating American practice on account of the rapid wear of the lining. In Germany furnaces run from 13 to 17 years on one lining. Moreover, in Germany coal and ore do not favor such yields as are possible with American ores. Others who took part in the discussion were WINDSOR RICHARDS, G. J. SNELUS, WM. WHITWELL and EDWARD MARTIN, of the Iron and Steel Institute, and Messrs. KENNEDY, KENT and WEEKS, of the American Institute.

President Sir JAMES KITSON then announced the formal presentation of the Bessemer gold medal and diploma to Hon. ABRAM S. HEWITT, President of the American Institute of Mining Engineers, for distinguished services to the iron and steel trades. He said that there were other men in America to whom this medal might rightly be awarded; but Mr. HEWITT'S services were such as to justly entitle him to it. Mr. HEWITT'S report on the Paris Exposition of 1867 was instrumental in bringing about the foundation of the Iron and Steel Institute of Great Britain.

Mr. HEWITT'S record is a record of firsts. The first Bessemer converter in the United States was erected under his direction in 1856. He was the first to build an open-hearth furnace, and has recently been identified with the first movement to introduce the basic process in America.

President HEWITT accepted the medal and diploma with an eloquent address. Disclaiming either scientific or practical knowledge sufficient to entitle him to the honor, he accepted it "in trust for the able engineers who have had to deal with the new processes for the manufacture of steel," as whose representative he appeared. He then described the

economic, social and political effects consequent upon the invention of Sir HENRY BESSEMER, which, he said, was to be ranked with the invention of printing, the construction of the magnetic compass, the discovery of America and the introduction of the steam engine.

He traced from BESSEMER's invention three great results: the doubling of the average wages of labor and its elevation in the moral and social plane, the ability of the United States to pay off its national debt, and the revolutionizing of modern commerce by the construction of steel vessels, with a resulting tendency toward the abolition of warfare.

An able paper by Mr. HENRY M. HOWE, of Boston, entitled "Notes on the Bessemer Process," was then presented, and showed as remarkable records for American converters as Mr. GAYLEY had shown for American blast furnaces. We have briefly commented upon this in another column. Adjournment was then taken. In the afternoon a large audience assembled in the hall and listened to the oration by JAMES DREDGE, of London, editor of *Engineering*, on the late ALEXANDER LYMAN HOLLEY. Afterward the audience adjourned to Washington Square, where the statue o HOLLEY was unveiled.

THE AMERICAN INSTITUTE OF MINING ENGINEERS and the British and German iron masters and metallurgists, who are its guests, have by no means confined their energies to attending the technical sessions at Chickering Hall, of which an account is elsewhere given. On Wednesday afternoon the steamer *Sandy Hook* took the party up the Hudson nearly to West Point, giving the visitors their first glimpse of American scenery. On Thursday morning a party under the escort of Mr. J. B. MACKINTOSH visited the works of the Consolidated Gas Co. In the evening the Iron and Steel Institute held its annual banquet, enjoying the far-famed delicacies of Delmonico's. Among the guests were Gen. SHERMAN and Messrs. HEWITT, BAYLES, SMITH and SHINN, of the American engineering societies At the same hour a reception was given to the members of the *Verein Deutscher Eisenhuettenleute* at the Liederkranz Society's club house, where the visitors were welcomed by CARL SCHURZ. On Friday morning the electrical works of the city were visited under the guidance of Dr. SCHUYLER S. WHEELER. For Friday afternoon the excursions set down were to the Edison laboratory, at Llewellyn Park, N. J., to the Tilly Foster iron mines, via the Harlem R.R., and up the East River by boat to the Navy Yard and the Washington Bridge.

ON Saturday morning the Western excursion begins, the party leaving at 9 A. M. in three special trains over the Pennsylvania R. R. Stops of some length are to be made at Philadelphia, Harrisburg, Pittsburg and other points. At Pittsburg meetings for the presentation and discussion of papers are to be held. The excursionists will reach Chicago on Monday, Oct. 13, and at the close of the visit there will separate, one part (considerably the larger part) going south through the iron and coal districts of Alabama, Tennessee and Virginia. The other party will go north to visit the iron and copper mines of the North Michigan peninsula and thence east via the Sault Ste. Marie, the Sudbury, Ont., copper and nickel mines and Niagara Falls. Both excursions will reach New York about Oct. 28.

THE TELPHER SYSTEM of electric traction, invented by the late Prof. FLEEMING JENKIN has been tried on a small scale at the Edinburgh Exhibition, where it attracted considerable attention from parties engaged in mining and excavating.

WORK ON THE NIAGARA WATER POWER TUNNEL has been commenced at shafts Nos. 1 and 3. Altogether 75 men are employed.

THE REMOVAL OF THE WESTINGHOUSE AIR BRAKE WORKS from Allegheny City to Wilmerding, Pa., is now an accomplished fact. The shops in Allegheny City are now occupied by the Fuel Gas and Manufacturing Company, another Westinghouse concern. A few days ago the last complement of air brake workmen left for the new shops in Wilmerding, which are perhaps the most perfect in the world of their kind.

The general offices of the company have also been located near the new works, while the company's city office is located in the Westinghouse Building, corner of Ninth St. and Penn Ave., Pittsburg, Pa., which is the property of the Westinghouse Air Brake Co. The new works at Wilmerding are now in full operation, and we learn that the increased facilities are being heavily drawn on from the first, the very rapid increase in the demand for freight brake gear having increased the business enormously, far beyond the capacity of the old works.

THE COWLES ELECTRIC SMELTING AND ALUMINUM CO. announce that hereafter they will charge $1.00 per pound for the aluminum in their various alloys as furnished to the trade. This is a reduction from the late price of $2.50 per pound in small lots, and from about $5 per pound in 5 years.

A NEW SMOKE PREVENTER is noted in *Industries* as having proved unusually efficient. A number of iron boxes with perforated sides are filled with asbestos and placed on the furnace bars just in front of the bridge. Curved arches of fire resisting material are placed immediately behind the bridge. These boxes and arches become white hot after the furnace gases have passed over them for a short time. The air entering in front of the bridge is heated, and it and the gases from the furnace pass between the spaces formed by the arches, which are so intensely hot that a fierce combustion is caused, entirely destroying the black smoke.

FUEL GAS RATES in Pennsylvania are stated by the Greensburg Fuel Co. to be as follows:

	Cook stove.	First grate.	Other grates.
Latrobe	$30.00	$17.80	$12.00
Manor	12.00	7.80	7.80
Scottdale	30.00	14.70	13.30

The rates for natural gas in Irwin are the same as in Manor, while residents of Painterville, Mt. Pleasant, Connellsville and Uniontown pay the Scottdale prices. The present price for gas in Pittsburg is 12½ cts. per M. cu. ft.

THE CHATTANOOGA BASIC STEEL PLANT, which was at first tested with charcoal pig, has received several charges of two parts coke pig and one part scrap. The heats were run in seven hours, and are reported as absolutely satisfactory, the phosphorus being thoroughly eliminated. Portions of the steel were subjected to cold bending and twisting tests, which they withstood with fracturing.

URAGUAY AND THE ARGENTINE REPUBLIC, according to a well informed correspondent who is about completing an engagement in those countries, "are very poor places at present for engineers seeking employment. American engineers can do better at home, and they would be unwise to come here without a definite contract from responsible parties. It seems likely to be several years before these countries will offer a more inviting field to engineers than the United States."

THE USE OF SEA WATER FOR FIRE PROTECTION is under consideration at Seattle, Wash. The Seattle Steam Heat & Power Co. has laid mains in the business part of the city for supplying steam for heating and water for operating elevators. The company is said to be a local one, many of its patrons being stockholders, and the buildings supplied have been prepared with stand-pipes with provision for hose connections on each floor, the whole to be used for fire protection. The company has large pumps at its station, which is near the shore, and wishes the city to lay mains from salt water to the pumps, and in return offers to furnish, free of cost to the city, water for fire protection in the district covered by the company's plant.

THE CHINESE IMPERIAL CABINET, in solemn conclave assembled, is "reported" to have decided that an electric light that came and went at the touch of a button could only be the offspring of supernatural power; and they then ordered the removal of the electric lights lately put into the Imperial palace.

AN ATLAS OF WESTCHESTER CO., NEW YORK, is being published by W. M. GOLDTHWAITE, of No. 107 Nassau St., New York, which promises to be of exceeding value to many interests. The atlas will be in one volume, and will show townships and outlying districts on a scale of 2 to 4 ins. per mile, and give all block, lot and ward numbers, block and lot dimensions, and all public and private buildings and factories, with the materials of construction indicated by color.

PERSONALS.

Mr. D. M. RANKEN has resigned his position as Water Commissioner of Troy, N. Y.

Mr. A. D. CAMPBELL has been appointed Town Engineer of Portage la Prairie, Man.

Mr. A. F. PRIEST has resigned his position as Master Mechanic of the Great Northern Ry.

Mr. D. McN. STAUFFER returned Sept. 27 from an extended trip through Egypt, Turkey and Russia.

Mr. J. SEWELL, Master Mechanic of the Georgia Southern & Florida R. R., has resigned his position.

Mr. H. ALEXANDER has resigned his position as Superintendent of the Columbia, S. C., water-works.

Mr. J. L. DUFFY, a member of the Engineer's Club of St. Louis, has been appointed Street Superintendent of that city.

Mr. JOHN THOMPSON, of the firm of Kellogg, Thompson & Co., water-works contractors, died in Denison, Tex., Sept. 27.

Mr. E. F. FULLER of New York City, is engaged in examining the plant of the Macon, Ga., Gaslight & Water Co., in the interest of Northern parties.

Mr. J. D. COLLINSON has been appointed Master Mechanic of the Chicago Division of the Atchison, Topeka & Santa Fé R. R. with headquarters at Chicago.

Chief Engineer STARK, of the Ottawa River canals, has been retired owing to ill health. He was formerly engaged on Intercolonial Ry. surveys in the maritime provinces.

Mr. WILLIAM SMITH has been appointed Superintendent of motive power and machinery of the Chicago & Northwestern Ry., filling the vacancy caused by the death of Mr. G. W. TILTON.

Mr. C. O. WHEELER, Superintendent of the Atchison, Topeka & Santa Fé lines east of the Missouri River, has accepted the position of General Superintendent of the Gulf, Colorado & Santa Fé Ry., with headquarters at Galveston.

Mr. DANIEL ULRICH has been appointed Assistant Engineer of Construction at the wharves of the Lehigh Valley Ry. at West Superior, Wis. Mr. ULRICH was recently engaged in dock construction at Buffalo, N. Y., for the Reading, R. R.

Mr. HENRY W. CANNON, President of the Chase National Bank, has been appointed by Mayor GRANT as an Aqueduct Commissioner to succeed the late WALTER HOWE. Mr. CANNON is an exceptionably able financier and business man, and his appointment meets with universal approval.

Mr. CHARLES MACDONALD, of the Union Bridge Co., has given to the Rensselaer Polytechnic Institute a fund sufficient to establish an annual prize of $120, to be given to the student who shall, at his graduation, present the best thesis involving an original design of an engineering work, or an original investigation of a process which may be of special interest to civil engineers.

Mr. E. W. MCKENNA is appointed Assistant General Superintendent of the Middle Division of the Chicago, Milwaukee & St. Paul Ry., with office at Milwaukee. Mr. D. C. CHENEY is appointed Superintendent of the La Crosse Division; Superintendent R. R. MINTURN, M. Am. Soc. C. E., is transferred to the Wisconsin Valley Division, with office at Tomah, and JAMES R. WILLIAMS is appointed Superintendent of the Iowa & Minnesota Division.

NEW PUBLICATIONS.

—*Annual Reports of the Chicopee Falls Fire District.* Apr. 30, 1890. Paper, 8vo, pp. 20.

—*Annual Report of the Pittsfield (Mass.) Fire District.* April 1, 1890. Paper, 8vo, pp., 32.

—*Ninth Annual Report of the Water Commissioners of Clinton, Mass.* Feb. 1, 1890. Paper, 8vo, pp. 16.

In addition to the usual matter this report contains monthly rainfall statistics for 1889.

—*Report of the South Adams Fire District.* March 12, 1890. Paper, pp. 12.

This report states the various purposes and their number, for which water is furnished, and the yearly revenues for the past 13 years.

—*Forty third Annual Report of the Village of Rutland (Vt).* Feb. 28, 1890. Paper, 8vo, pp 76.

In his section of this report the health officer urges that he be given authority to compel all persons owning buildings located on streets provided with sewers to connect with the same.

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

Published Weekly at Tribune Building, New York.

Vol. XXIV. Saturday, October 4, 1890.

D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST.....BUSINESS MANAGER

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COMING TECHNICAL MEETINGS.

American Institute of Mining Engineers.—International meeting with the Iron and Steel Institute of Great Britain and the Verein Deutscher Eisenhuettenleute as guests, now in progress. Meetings are held in Chickering Hall. Secy., Charles Kirchoff, Jr., 66 Duane St., New York.

Association of Civil Engineers of Dallas.—Next meeting, Nov. 7. Secy., E. K. Smoot, Elm and Austin Sts.

Technical Society of the Pacific Coast.—Next meeting Nov. 7. Secy., O. von Geldern, 408 California St., San Francisco.

Engineers' Club of Philadelphia.—Next meeting, Oct. 4. Secy., Howard Murphy, 1122 Girard St.

Civil Engineers' Society of St. Paul.—Next meeting, Oct. 6. Secy., G. L. Wilson.

Western Society of Engineers.—Next meeting, Oct. 7. Secy., J. W. Weston, 230 La Salle St., Chicago.

American Society of Railway Superintendents.—Annual meeting at New York, Oct. 7, at Hotel Brunswick. Secy., C. A. Hammond, 350 Atlantic Ave., Boston, Mass.

Civil Engineers' Association of Kansas.—Next meeting, Oct. 8. Secy., J. C. Herring, Wichita, Kan.

Engineering Association of the Southwest.—Next meeting, Oct. 9. Secy., Olin H. Landreth, Vanderbilt University, Nashville, Tenn.

American Society of Swedish Engineers.—Semi-annual meeting, Oct. 11. Secy., M. Dahlander, 320 Sackett St., Brooklyn, N. Y.

Denver Society of Civil Engineers.—Convention at Manitou, Oct. 10 and 11. Secy., Geo. H. Angell, 36 Jacobson Bldg.

Civil Engineers' Club of Cleveland.—Next meeting, Oct. 14. Secy., C. O. Palmer, 22 Cedar Ave.

Engineers' Club of St. Louis.—Next meeting, Oct. 15. Secy., W. H. Bryan, 30 South 7th St.

American Society of Civil Engineers.—Next meeting Oct. 15. Secy., John Bogart, 127 E. 23d St., New York.

Boston Society of Civil Engineers.—Next meeting, Oct. 15. Secy., S. E. Tinkham.

New York Railway Club.—Next meeting, Oct. 16. Rooms, 113 Liberty St.

Engineers' Club of Cincinnati.—Next meeting, Oct. 16. Secy., J. F. Wilson.

Western Railway Club.—Next meeting, Oct. 21. Rooms, Phenix Building, Chicago. Secy., W. D. Crosman, 816 Rookery, Bldg.

Engineers' Society of Western Pennsylvania.—Next meeting, Oct. 21. Secy., S. M. Wickersham, Pittsburg, Pa.

AMERICANS, as a rule, are always glad to be able to pay their debts. A year ago a large delegation from the principal engineering societies of America went abroad and received a bounteous hospitality at the hands of their foreign brethren, in whose praise they have been lavish ever since. This week the opportunity has come to render a similar hospitality to a delegation 500 strong from the British Iron and Steel Institute and the *Verein Deutschen Eisenhuettenleute.* Ample preparations for the entertainment of the guests have been made, and in the month's tour which the party is to make through the country there seems every reason to expect that whatever the visitors may think of American engineering works, they will be thoroughly impressed with the extent and genuineness of American hospitality.

It is not a mere junketing tour, however, which the chief metallurgists of Great Britain and Germony have come here to enjoy. They are here to learn what Americans are doing in engineering and metallurgy, and their hosts intend to give them every opportunity to gratify the desire. It is not hard to discern, moreover, a considerable feeling of pride among the American engineers in the showing they are able to make; and a very pardonable pride it is. The proceedings of the sessions for the discussion of technical papers have been of greatest interest when American practice was under comparison with foreign. The very first paper read at the session of the Iron and Steel Institute caused a genuine sensation among the foreign visitors. The paper was by Mr. JAMES GAYLEY, of the Edgar Thomson Works, at Braddock, Pa., and described "The Development of American Blast Furnace Practice, With Especial Reference to Large Yields." In a modest way Mr. GAYLEY gave a brief history of the changes in American practice and presented the actual figures of the production and fuel consumption of several furnaces, closing with furnace No. 7 of the Edgar Thomson Works.

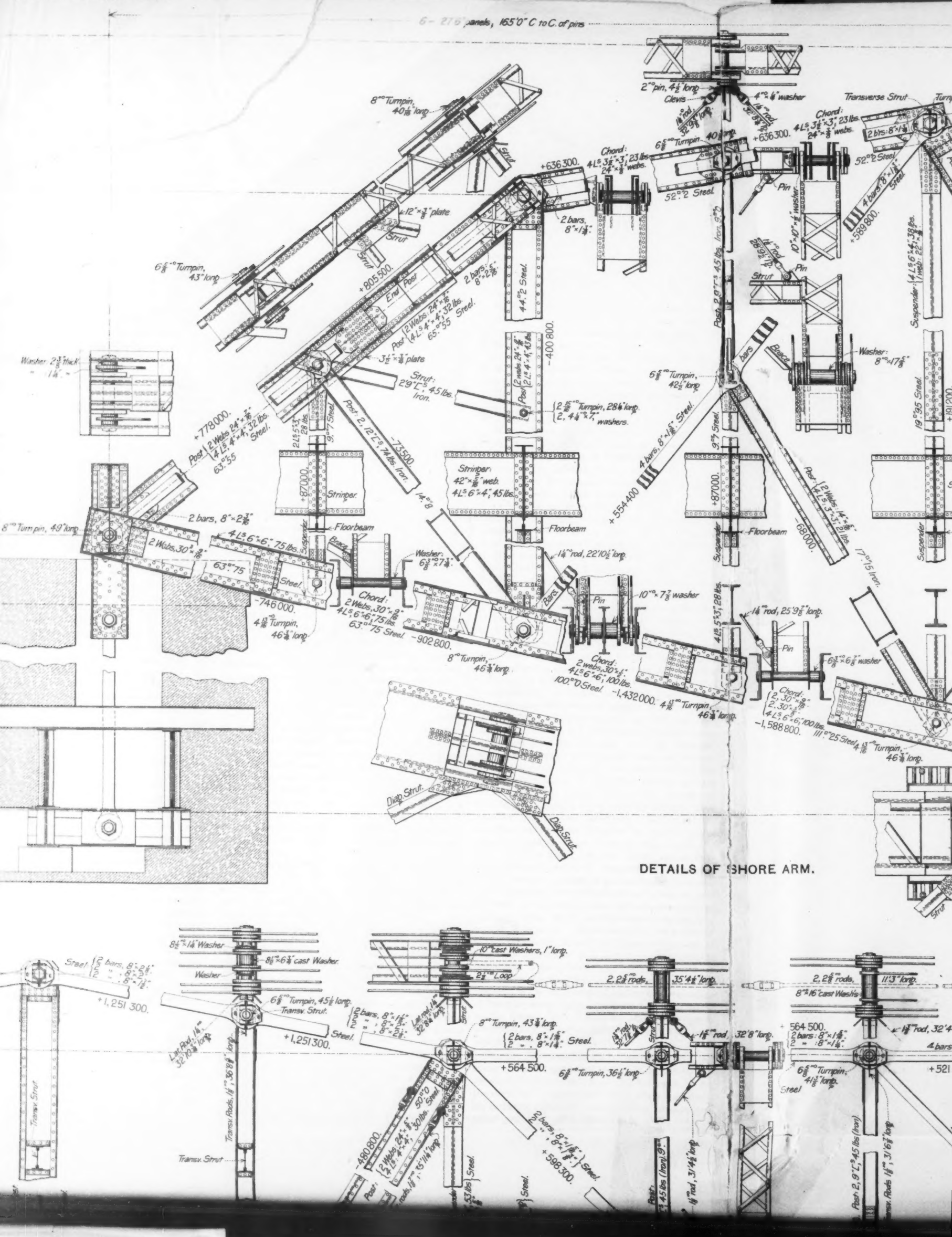
Only the experts, however, realized what a wonderful record Mr. GAYLEY had described until Sir LOWTHIAN BELL, like the magnanimous and openhearted Englishman that he is, rose and said that the production recorded at the Edgar Thomson works was *five times* what any furnace in North Yorkshire could claim, and *twice* as much as that of the best furnaces in England working on brown hematite ores. And the British guests who listened applauded as heartily as if the feat had been performed on English soil.

So interested were the visitors in this remarkable record of blast furnace work that the discussion on this paper was prolonged over two sessions, and the generous visitors were as unsparing in their praise of the unprecedented feat as they were diligent in their criticism of possible weak points in American practice. And in the very next paper on the list they learned a fact, doubtless not new to many of them, that in other departments of metallurgy America is as far in the lead as she is in blast furnace practice. Prof. HENRY M. HOWE of Boston opened his able paper on the Bessemer process by saying that the striking feature of American Bessemer practice was its large output. Just how large this is compared with British practice it was left for another generous Englishman, Mr. J. E. STEAD, to explain, by saying that if English Bessemer rail mills had an output equaling American mills of like size, *five* would produce the same output which now comes from *fifteen.*

IT is but fair to assume that the government ordnance officers know what they are about in attaching the weight which appears to be attached to the Annapolis armor tests which are illustrated in this issue. Their approval has gone so far that the immediate purchase of $1,000,000 worth of nickel has been authorized. But it appears to us that the utmost which can properly be said for the tests is that they were interesting experiments which may or may not be really trustworthy. In several respects the tests would be regarded among competent civil engineers accustomed to testing material as quite too limited in range to base any important conclusions on; and surely no conclusions could well be more important than those which determine the offensive and defensive efficiency of many million dollars' worth of ships, on which the safety of our coasts may depend. In the first place, it was preposterous to stop the tests where they were stopped with the plates in the condition shown by our views. ALL the plates should have been tested to destruction. The compound plate was practically destroyed as it was; but who can tell that another shot on each of the all-steel plates might not have shattered the nickel plate even worse than the other? The nickel plate was clearly the better of the two under the conditions tested, but the real question is, or should have been, how much better? Would it have stood one or two or three more shots without cracking like the steel plate? Was or was not the steel plate still as practically effective for resisting two or three more shots as the nickel-steel plate? These are questions which should have been answered by continued trial, and not guessed at. It would have been an easy matter to fire a few more shots with either the 6-in. or 8-in. gun, and thus remove all chance for doubt, while definitely settling what no one now knows, whether there was a great or small difference between the two most successful plates. If a small difference, surely further investigation was imperatively demanded.

IN the second place, what rational engineer, experimenting in a field decidedly outside of the range of previous routine, decides to purchase thousands of articles of any kind on tests of one sample only, especially a sample which was expressly prepared as such? Under the usual methods of civil engineers, at least three plates of each kind would have been tested before venturing to draw final conclusions. Who knows that the nickel plate was not largely a lucky hit, or that 5 or 10 per cent. of them may not be unlucky ones? It is an almost new material, and the knowledge of it is very limited. And who can say that the Cammell compound plate was not a specially unlucky one, with serious, accidental or other defects in it? We know it to be true, that in very recent English tests of 24-in. compound plates made by the same company (8 ins. steel and 16 ins. wrought iron, united in the usual way by molten steel run in between them), the compound plates made a far better showing than the all-steel, the latter fracturing under 5 shots from a 12-in. gun (we believe), much as did the same kind of plate at Annapolis, with an X-like fracture, while the compound plate made a showing like the nickel plate at Annapolis, instead of the lamentable fiasco which we picture. Which of these tests is the true index to quality? They can hardly be both trustworthy, since they are in direct conflict with each other.

THIS brings us to the third objection to these tests, that they do not cover range enough, either in thickness or in striking velocities. The assumption made both by our own and British officers, as we understand it, is that the shots at close range from a 6-in. gun will fairly represent the effects of heavier pieces at longer fighting ranges. So they will in foot tons of striking energy, but it is a truism among civil engineers that the same energy of blow from a great weight with low velocity and a small weight with high velocity produce very different effects, as illustrated daily in pile driving, and perhaps still more forcibly in the homely experiment of


6 - 27'6" panels, 165'0" C. to C. of pins
8"° Turnpin, 40 1/8" long
Strut
12" × 3/8" plate
Strut
Strut
6 5/8"° Turnpin, 43" long
+805 500.
End Post
2 bars, 8" × 2 5/8"
Post (2 Webs, 24" × 7/16", 4 L's 4" × 4", 32 lbs. 65°.55 Steel.
3 1/2" × 3/4" plate
Strut: 2 9"C" 45 lbs. Iron.
Post: 2, 12"C"s, 74 lbs. Iron.
14°.8
-73500
Washer 2 3/8" thick
" 1/4" "
+778000.
Post (2 Webs 24" × 7/16", 4 L's 4" × 4", 32 lbs. Steel. 63°.55
2 L's 3" 28 lbs.
9"7 Steel.
+87000.
Stringer.
Floorbeam
Suspender
Brace
Washer: 6 3/8"° × 7 3/8"
Chord: 2 Webs, 30" × 9/16", 4 L's 6" × 6" 75 lbs. 63°.75 Steel.
-902 800.
8"° Turnpin, 46 3/4" long
2 bars, 8" × 2 5/16"
8"° Turnpin, 49" long
2 Webs, 30 1/4" × 9/16"
4 L's 6" × 6" 75 lbs.
63°.75 Steel.
-746 000.
4 13/16"° Turnpin, 46 3/4" long
+636 300.
Chord: 4 L's, 3 1/2" × 3", 23 lbs. 24" × 1/2" webs.
2 bars, 8" × 1 1/2"
44°.2 Steel.
-400 800.
Post (2 webs 24" × 7/16", 2 L's 4" × 4", 45 lbs.
2 5/16"° Turnpin, 28 1/2" long
2, 4 1/2"° × 1/2" washers.
Stringer: 42" × 5/16" web. 4 L's 6" × 4", 45 lbs.
Floorbeam
1 1/4"° rod, 22' 10 1/2" long
Brace
Pin
10"° × 7 7/8" washer
Chord: 2 webs, 30" × 1/2", 4 L's 6" × 6", 100 lbs. 100°.0 Steel.
-1,432 000.
4 13/16"° Turnpin, 46 3/4" long
Diag. Strut.
Diag. Strut.
2"° pin, 4 1/2" long
Clevis
4"° × 1/4" washer
1 1/4"° rod, 32' 8 3/8" long
+636 300.
6 5/8"° Turnpin, 40 1/8" long
Chord: 4 L's, 3 1/2" × 3", 23 lbs. 24" × 1/2" webs.
52°.2 Steel.
Pin
Post, 2 9"C"s 45 lbs. Iron, 9"°
1 1/4"° rod, 26' 2 1/2" long
Strut
Pin
10" × 10" × 1" washer
Transverse Strut
2 bars: 8" × 1/2"
4 bars, 8" × 1 1/2" Steel.
+589 800.
Suspender: (4 L's 6" × 4", 38 lbs. / web: 22' 3 1/2" long)
4 bars, 8" × 1/2" Steel.
+554 400
Post: (2 Webs, 14" × 5/16", 4 L's 3" × 3", 21 lbs.
-68000.
Suspender
Floorbeam
17°.15 Iron.
6 5/8"° Turnpin, 42 1/2" long
Bars
Brace
Washer: 8"° × 17/8"
19°.35 Steel.
+191 200
Suspender: (4 L's 6" × 4", 38 lbs. / web: 22' 3 1/2" long)
4 L's 6" × 6" 100 lbs.
111°.0 25 Steel.
4 13/16"° Turnpin, 46 3/4" long.
-1,588 800.
6 7/8"° × 6 7/8" washer
4 L's 5" × 3" 28 lbs.
1 1/4"° rod, 25' 9 7/8" long.
Pin
Strut
DETAILS OF SHORE ARM.
8 1/2"° × 1 1/4" Washer
8 1/2"° × 6 3/4" cast Washer
Washer
6 5/8"° Turnpin, 45 1/2" long.
Transv. Strut.
Steel { 2 bars, 8" × 2 1/2" 2 " 8" × 2" 8" × 1/2"
+1,251 300.
Lat. Rod, 1 1/4" 32' 10 3/8" long
Transv. Rods, 1 1/4"°, 36' 8 1/8" long
Transv. Strut
Transv. Strut
10" cast Washers, 1" long.
2 1/2"°" Loop
Lat. rod, 1 1/4" 32' 8 3/4" long
Strut
8"° Turnpin, 43 3/4" long
{ 2 bars, 8" × 1 1/2" 2 " 8" × 1/4" } Steel.
+564 500.
6 5/8"° Turnpin, 36 1/2" long
-490 800.
{ 2 Webs, 24" × 5/16", 4 L's 4" × 4", 30 lbs. } Steel.
50°.0 Steel.
{ rods, 1 1/4"°, 5' 11 1/4" long } 53 lbs. } Steel.
Post:
+598 300.
{ 2 bars, 8" × 1 1/2" 8" × 1 3/8" } Steel.
2, 2 3/8"° rods, 35' 4 1/2" long.
1 1/4"° rod, 32' 8" long.
Strut
Post: 2 9"C" 45 lbs (Iron) 9'.
1 1/4"° rod, 3' 4 1/2" long
2, 2 3/8"° rods, 11' 3" long.
8"° × 16" cast Washers
564 500.
{ 2 bars: 8" × 1 5/8" 2 " 8" × 1 1/4" }
1 1/8"° rod, 32' 4
4 bars
6 5/8"° Turnpin, 41 3/4" long.
Steel
+521
Post: 2, 9"C" 45 lbs (Iron) 3' 1 3/4" long
Transv. Rods 1 1/4"°, 3' 1 6 3/4" long

Transverse Strut
Steel.
8"ø Turnpin, 36¾" long.
+1,251 300.
6⅞"ø Turnpin, 40⅝" lg.
Pin
1¼"rod 36'9⅞" lg.
Washer
8½"×2½" cast washer.
Turnpin 8"ø, 47½" long.
Post: 2 Webs, 24"×½", 4 L's 4"×4", 50 lbs. 62"
Steel
Transverse Strut
Brace 9⅞"×⅛" plate
Suspender: 4 L's 6"×4", 38 lbs. Web: 22"×⅜"
-617 600.
Post: 2, 12"ø, 60 lbs. 12" iron.
Strut
Pin
Brace
53" I Steel.
-468 000.
Post
Strut
4.5 lbs. (iron)
2⅛"ø Turnpin, 16" long.
Post
Strut
Brace
19" 95 Steel.
+191 200.
2-2½"×⅝" plates.
2-14"×⅝"
Stringer
Floorbeam
Suspender
4⅛"ø Turnpin, 36¼" long.
Strut 2.9"ø
4⅛"×3 28 lbs.
Post: 2-12"ø, 65 lbs. (Iron)
Stringer
+87000.
Floorbeam
9"ø I Steel.
Post
Strut
Plate
-695 700.
1¼" Steel.
Post: 2 Webs, 24"×½", 4 L's 4"×4", 50 lbs.
-529 300.
Bracket
2" pin, 5" lg.
1¼"rod, 29'6⅝" long.
Pin
6⅞"ø 3½" washer.
-1,738 100.
2 webs 30"×⅝"
2 " 30"×⅝"
4 L's 6"×6", 100 lbs.
Suspender
1¼"rods
2" pin, 4½" long
Plate
2"pin, 5½"
Plate
Plate
1⅛"rods, 45'0½" lg.
Pin
Post
Chord
6⅞"ø 6⅝" washer.
Chord: 4 webs, 30"×⅝"
4 L's 6"×6", 100 lbs.
-1,894 900.
118"ø 75 Steel.
4⅛"ø Turnpin, 46¾" long.
130"ø Steel
Plan of Pedestal.
Shoe
Pedestal
15"ø Turnpin, 58¼" long.
1⅜"ø Foundation bolts 4'0" long.
Strut
Strut
Strut
2, 2⅝"ø rods.
8"×22⅛" cast Washer.
8"×3½" "
Chord
Wedge box.
Wedge box.
2½" Loop 13'0" long.
9½"×7" Washer
Chord
8"ø Turnpin 32½" lg.
8"ø Turnpin, 33½" lg.
Plate
1¼ Rod, 32'2½" lg.
1¼"ø Rod, 32'0¼" lg.
8"ø Turnpin, 53½" lg.
Rod, 32'4" long.
4 bars: 7"×1⅜" Steel.
Friction rod.
+521 500.
+521 500.
4 bars, 7"×1⅜" Steel.
6⅝"ø Turnpin, 48¾" lg.
Strut
Frame
Wedge
Plate
Plate
Note: Upper Wedge to be entered far enough to make this panel 270' C. to C. of pins.
2 bars, 6"×⅞" Iron.
+67 600.
Transv. Rods 1⅛" 39'10¼" long.
Transv. Rods, 1⅛" 30'9⅛" long.
9"D Post: 2, 9"×⅜" 45 lbs (Iron)
Post: 2 Webs, 30"×⅜", 4 L's 6"×6", 75 lbs.
-737 500.
71"25
2⅛" Hanger, 3'0" lg.
6"×2½" Plate, 5" long.
2⅛"ø rods, 21'5" long.
2⅜"ø Screw rods, 11'0" long.
8½"×3¼" Washer
8½"×6½" "
Strut
Steel
101'0" Cen. to Cen. of pins
Cent. Line of Span.
Chord
Strut
Strut
Chord
Strut
Chord
Strut
Chord

DETAILS OF SHORE ARM.

101'0" Cen. to Cen. of pins

Chord

12"×⅝"×19½" plate

1¼" rod, 33'3½" long

1¾" upset rod, 37'1¾" long

Strut

1¾" upset rod, 37'5" long

2 L⁵ 4"×3½"×⅞", 21 lbs.
1 L⁵ 3½"×3"×½", 8 lbs.

1¼" upset rod, 37'2⅜" long

1¼" upset rod, 37'1⅜" long

Cent. Line of Span.

8" Turnpin, 26 16" lbs.

Lat'l plate

⅞" Turn bolts, 3½" long

⅞" Turn bolts, 4½" long

Chord

1 Cover, 24"×½"
2 Webs, 24"×⅜"
2 Top L⁵ 3½"×3"×½", 26 lbs.
2 Bot L⁵ 6"×4"×⅞", 67 "

-608290.
57.0 "6 Steel.

1 Cover, 24"×½"
2 Webs, 24"×⅜"
2 Top L⁵ 3½"×3"×½", 26 lbs.
2 Bot L⁵ 6"×4"×⅞", 67 "

Chord:

1 Cover, 24"×½"
2 Webs, 24"×⅜"
2 Top L⁵ 3½"×3"×½", 26 lbs.
2 Bot L⁵ 6"×4"×⅞", 67 "

-680800.
63.0 "6 Steel.

1 Cover, 24"×½"
2 Webs, 24"×⅜"
3½"×3"×½", 26 lbs.
2 Bot L⁵ 6"×4"×⅞", 67 "

Strut

⅝" Turn bolts, 3½" long

6"×⅝" hood

23⅝"×⅞"×1'11" Jaw Plate.

Plate

Chord

10"×⅛" Washer.

2⅛" Turnpin, 21¼" long.

4⅛" Turnpin, 21¼" long over all.

Pin, 5" lg.

1¼" rod, 32'1⅛" long

2⅛" Turnpin, 21¼" long.

4⅛" Turnpin, 21¼" lg.

Pin

1¼" rod, 32'1⅛" long

54'6 Steel.

2 bars, 6"×¼", 50'2½" c. to c. Steel.

+147370.

2 bars, 7"×1⅛", 38'10⅛" c. to c. Steel.

+349400.

97 lbs. 45 lbs. (Iron)

-10660.

Transv. rods.

Transv. rods, 1⅛"

+159700.

2 bars, 6"×⅞", 38'10⅛" c. to c. Steel.

2, 9 L⁵ 45 lbs. Iron.

Transv. rods, 1⅛"

-10600.

Iron. 2 bars, 4"×⅞", 38'10⅛" c. to c.

+51400.

2, 12 L⁵ 60 lbs. Iron, 12"

Transv. rods, 1⅛"

1¾" upset rod, 31'10⅛" long

2" pin, 5" long

Cast Washer.

Transv. Strut

6⅞" Turnpin, 22¼" lg.

-123630.

18"98 Iron

Transv. Strut

6⅞" Turnpin, 23¼" lg.

Iron. 9 L⁵ 45 lbs.

2" pin
9 L⁵ 45 lbs.

Iron.
12"×⅜"×26 plate

Transv. Strut

Rod

Plate

Post

8½"×2 Cast Washer

Strut

Transv. Strut, 4 L⁵ 2½"×3½", 18 lbs. latticed

Kneebrace

-63860

2, 12"I⁵ 60 lbs.

12" Iron

Floorbeam

(2 Webs, 14"×⅝"
4 L⁵ 3"×3"×½", 18 lbs. Iron.

15"×95 Iron.

-59880.

(Steel) 2 bars, 5"×⅝"

22'8⅜" c. to c.

+74030.

Knee, 2 L⁵ 3"×2½", 16 lbs.

15"×95

-59880.
+4790.

+74030.

2 bars, 5"×⅝"

Steel.

2 bars, 6"×⅝", 38'10⅛" c. to c. Steel.

+129800.

Box

6⅞"×6½" Washer

4⅛" Tpin, 16" long.

Floorbeam

Post

Floorbeam

Floorbeam

Bracket

6"×3½"×⅝", 40 lbs, 12' long.

Floorbeam

+638000.

Chord { 2 Webs, 24"×½"
4 L⁵ 4"×4", 38 lbs.

Plate

35.0 "2 Steel.

+696000.

Chord { 2 Webs, 24"×½"
4 L⁵ 4"×4", 38 lbs.

3½"×⅞"×3'3" Splice plate.

37.0 "6 Steel.

+985000.

Steel 4 bars, 7"×1⅛".

4 bars, 7"×1⅛".

4⅛" Turnpin, 30⅜" long.

4⅛" Turnpin, 30⅜" long.

6⅞" Turnpin, 38⅝" lg.

6⅞" Turnpin, 37⅜" long.

6⅞" Turnpin, 36⅞" long.

27'6"

27'6"

27'6"

27'6"

27'6"

12, 27'6" Panels = 330'0" Center to Center of End Pins.

550' Center to Center of Chords

Plate

Bott. Spl. Plate
34"×⅞"×3'3"

Loops

2⅛" pin, 6¾" long.

1½" loops.

2, 2½" upset rods 31'9⅛" long.

Plate

Loops

2⅝" pin, 6½" lg.

Loops

2, 2½" upset rods 31'9⅛" long.

Plate

Bars

1⅞" Loops

2⅛" pin, 5¾" long.

2, 2½" upset rods 31'9⅛" long.

Plate

8½"×2⅞" cast Washer

Washer

Bars

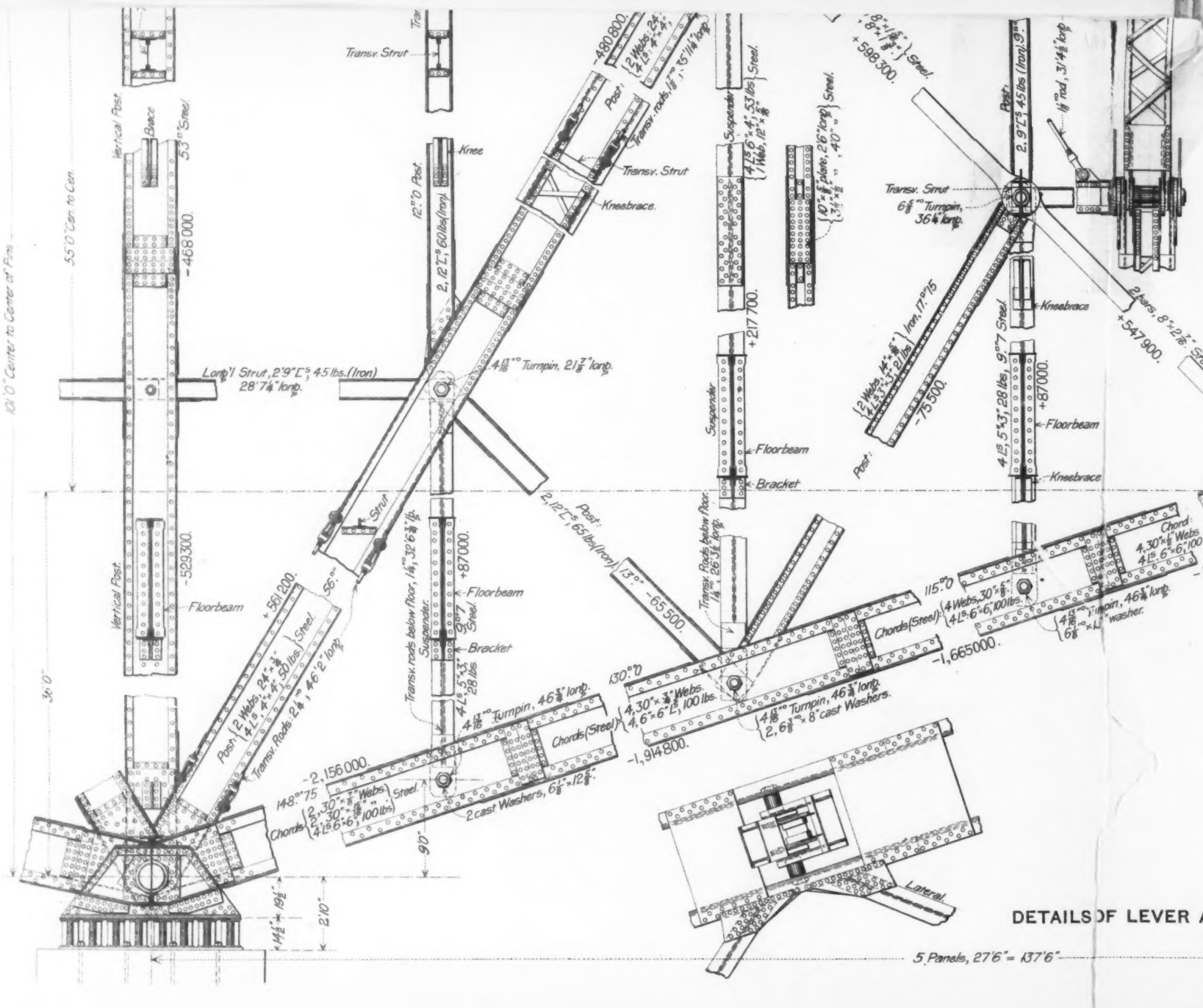
1⅞" pin, 5¾" long.

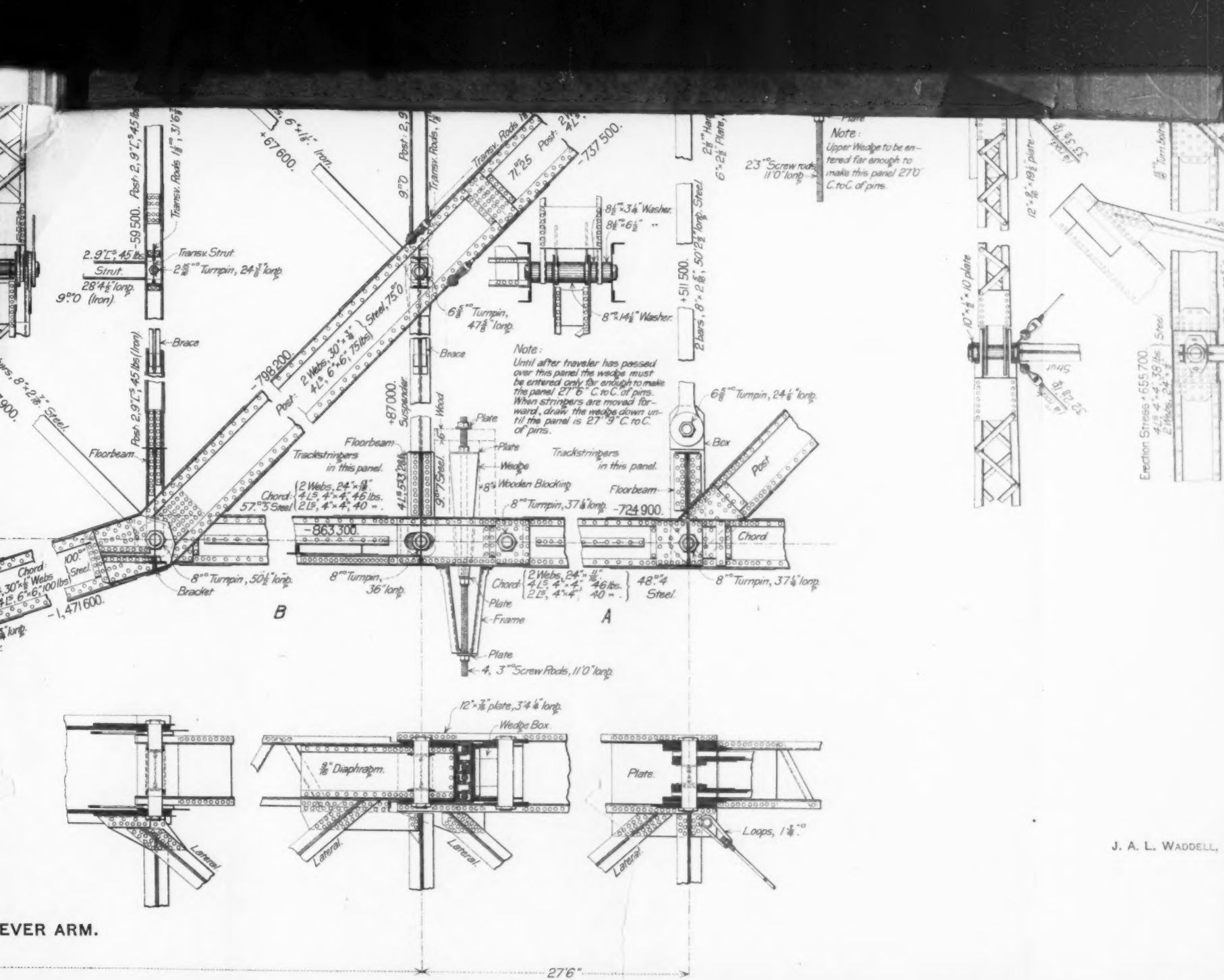
1, 2" upset rod 32'7⅞" long.

Plate

1, 1¾" upset rod 32'10⅞" long.

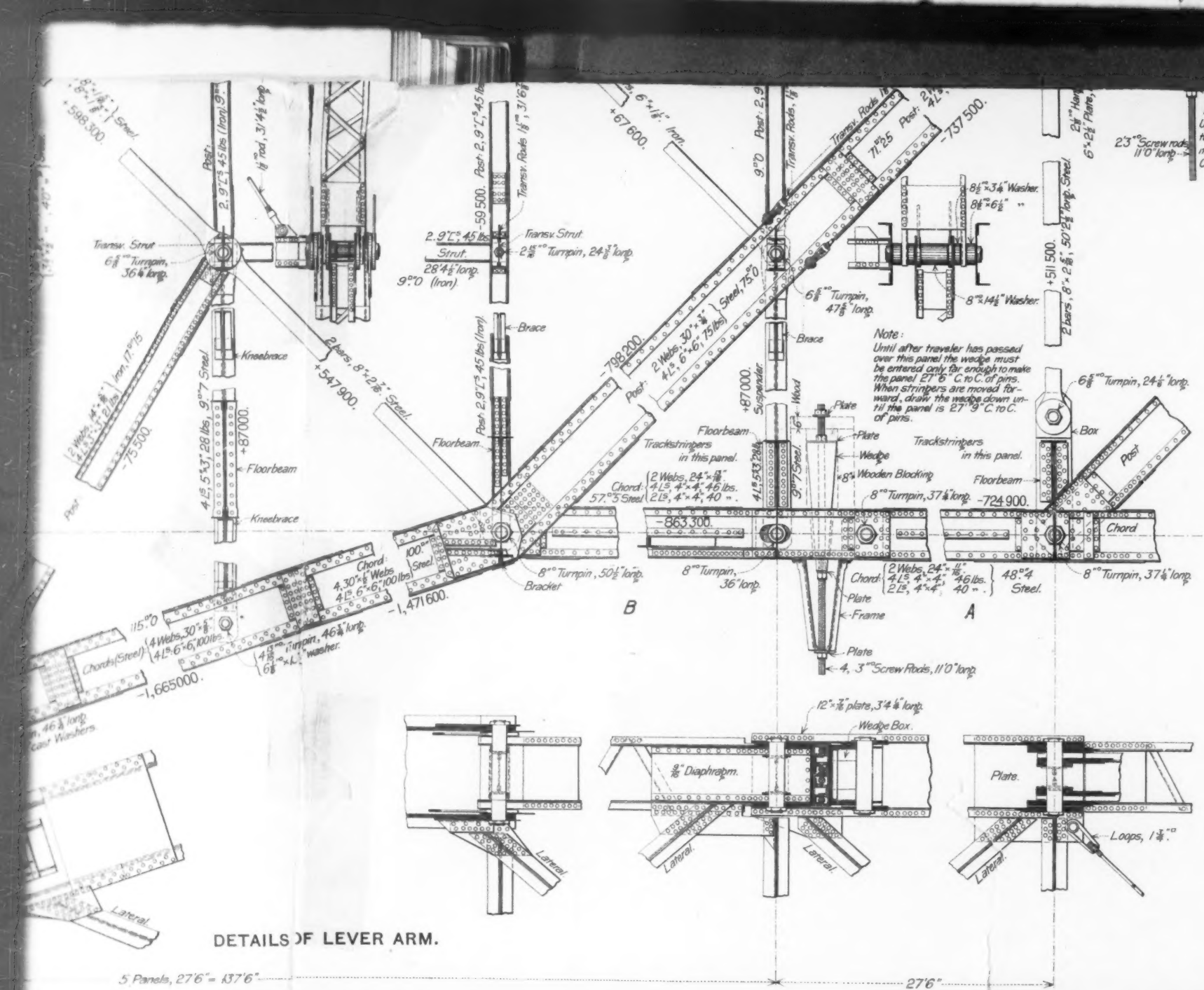
DETAILS OF SUSPENDED SPAN.

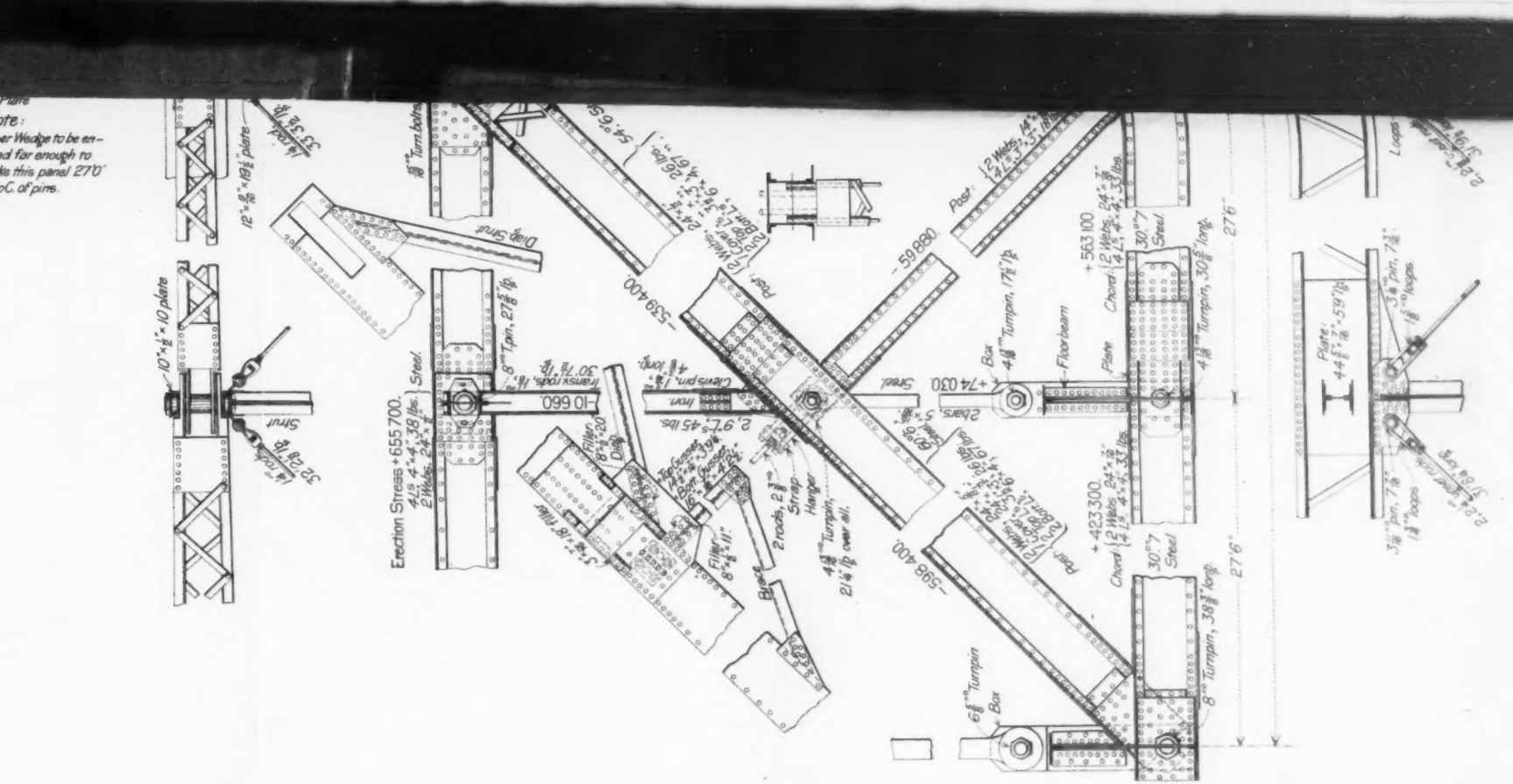

Transv. Strut
Vertical Post
Brace
53"ø Steel
55'0" Cen to Cen
101'0" Center to Center of Pins
-468000.
Knee
12'0" Post
2, 12"C's, 60 lbs (Iron)
Kneebrace.
Transv. Strut
Transv. rods 1⅛"ø; 15'11¼" long.
2 Webs, 24"×⅜"
4 L's 4"×4"×⅜"
Post
-490800.
Suspender
4 L's 6"×4"×⅝"
1 Web, 12"×⅜"
53 lbs/ft Steel.
+217700.
10"×⅝" plate, 26'0" long
3½"×⅝" " , 40" "
Steel.
Transv. Strut
6⅝"ø Turnpin, 36¼" long.
Post
2, 9"C's 45 lbs (Iron)
1¼"ø rod, 31'4½" long.
+598300.
Steel.
Kneebrace
2 bars, 8"×2⅞"
+547900.
2 Webs, 14"×⅜"
4 L's 3½"×3½"×½"
82 lbs/ft
Iron, 17'0"
-75500.
4 L's, 5"×3", 28 lbs, 9'0" long
Steel.
+87000.
Floorbeam
Kneebrace
Long'l Strut, 2'9"C's 45 lbs. (Iron)
28'7¼" long.
4 15/16"ø Turnpin, 21⅞" long.
Floorbeam
Bracket
Suspender
Strut
2, 12"C's, 65 lbs (Iron)
Post
13'0"
-65500.
Transv. Rods below Floor
1¼", 26'3½" long.
Vertical Post
+561200.
Floorbeam
-529300.
56'0"
Post
2 Webs, 24"×⅜"
4 L's 4"×4"×½"
50 lbs/ft
Steel.
Transv. Rods 2¼"ø 46'2" long.
Transv. rods below Floor, 1¼"ø, 32'6⅜" lg.
Suspender
9"C's 13.25 lbs Steel.
+87000.
Floorbeam
Bracket
4 L's 5"×3"×⅜"
28 lbs
4 15/16"ø Turnpin, 46⅜" long.
Chords (Steel)
-2,156000.
148'0"75
Chords
2, 30"×⅞" Webs
2, 30"×⅞" Webs
4 L's 6"×6"×100 lbs
Steel.
2 cast Washers, 6⅛"×12⅝".
90°
30'0"
14½"
19½"
2'10"
Transv. Rods below Floor
Suspender
Chords (Steel)
4, 30"×⅜" Webs
4, 6"×6"L's, 100 lbs.
-1,914800.
130'0"
115'0"
4 Webs, 30"×⅜"
4 L's 6"×6", 100 lbs.
-1,665000.
4 15/16"ø Turnpin, 46⅜" long.
2, 6⅜"ø×8" cast Washers.
Chord
4, 30"×⅝" Webs
4 L's 6"×6", 100
4 15/16"ø Turnpin, 46⅜" long.
6⅛"ø×1½" washer.
Lateral
5 Panels, 27'6" = 137'6"
DETAILS OF LEVER A


Note:
Upper Wedge to be entered far enough to make this panel 27'0" C. to C. of pins.
23'0" Screw rods, 11'0" long.
Note:
Until after traveler has passed over this panel the wedge must be entered only far enough to make the panel 27'6" C. to C. of pins. When stringers are moved forward, draw the wedge down until the panel is 27'9" C. to C. of pins.
Transv. Rods 1⅛" ; 3'6" long.
Transv. Strut
Strut.
Brace
Floorbeam
Trackstringers in this panel.
Plate
Wedge
Box
Post
Chord
Bracket
Suspender
Wood
Frame
4, 3" Screw Rods, 11'0" long.
Lateral
Wedge Box.
Diaphragm.
Loops, 1¼" ø
27'6"

EVER ARM.

J. A. L. WADDELL,


Note:
Until after traveler has passed over this panel the wedge must be entered only far enough to make the panel 27'6" C. to C. of pins. When stringers are moved forward, draw the wedge down until the panel is 27'9" C. to C. of pins.
Note:
Upper Wedge to be entered far enough to make this panel C. to C. of pins.
Transv. Strut
Strut.
Brace
Kneebrace
Floorbeam
Trackstringers in this panel.
Chord
Bracket
Plate
Wedge
Box
Post
Chords (Steel)
Lateral
Wedge Box.
Diaphragm.
Loops, 1 3/4".
DETAILS OF LEVER ARM.
5 Panels, 27'6" = 137'6"
27'6"



Red Rock Cantilever Bridge,

across Colorado River, Atlantic & Pacific Ry.

J. A. L. Waddell, Designing Engineer. Phœnix Bridge Co., Sooysmith & Co., } Contractors. Saml. M. Rowe, Chief Engineer.

Chas. Hart & Sons, Lith., 36 Vesey St., N.Y.

firing a tallow candle through a board. Now, who is entitled to say that with the lower velocities of larger projectiles likely to be encountered in action, albeit striking no "harder blow" in foot-tons, the steel face of the compound plate might not have effected its purpose of smashing the projectile instead of being itself smashed, as a board would smash a slowly moving tallow candle? There is an obvious convenience in using practically muzzle impacts from small pieces for such tests. The shots can be planted in the plate with geometric precision and there is less trouble in preparing for the tests; but after all, does it not defeat the objects of the tests if certainty is what is aimed at? It appears to us to do so. The all-steel plate in the late tests showed considerably more elastic action than the nickel plate, and with lower velocities might well have made the best showing, as might also have been the case had all the plates been thicker. A thickness of 10½ ins. would a few years ago have seemed ample, but to-day 18, 20 and 24-in. plates are being used extensively.

THESE doubts seem particularly well founded in view of the fact that in April of this very year compound plates were tested in England under almost precisely similar conditions with very different results. The plates were 8 × 6 ft. × 10½ ins., fired at by a 6-in. gun at 30 ft. range; Holtzer projectiles; muzzle velocity, 1,976 ft; all identical with the late tests except the muzzle velocity, which at Annapolis was 2,075 ft., giving a muzzle energy of 3,300 ft.-tons against 2,800. Chilled Palliser projectiles were reduced to dust against this plate, while the Holtzer shells were considerably splintered, the heads remaining embedded in the plate. At the fifth round only did the projectile touch the backing. "A few cracks were produced, but it was evident that under the prescribed test the crew of a ship would have been protected against shell fire." Moreover, some Dutch competitive tests of different kinds of 11-in. compound armor, fired at by an 11-in. gun with 7,079 ft.-tons striking energy, but only 1,355 ft. per second striking velocity, showed much less injury to Cammell plates on the whole than that resulting to but little thinner plates from the four 6-in. shots pictured elsewhere. All these facts taken together certainly raise grave doubts of the propriety of regarding the Annapolis tests as conclusive of anything except of the need of more tests before definite action is resolved on.

THE reduction in price to $1 per pound of the aluminum contained in the alloys produced by the Cowles process, as lately announced by that company, marks an event of unusual interest and as yet untold value in the history of metallurgy. It is but a few years ago since this useful metal was worth $20 per pound, and then only attainable in small quantities. Within 5 years it has been reduced from $5 per pound to the figure quoted above, and we know that responsible manufacturers of aluminum, pure as well as alloyed, stand ready to contract for any amount that the trade may demand, and by tons instead of by pounds. As the metal is of so recent introduction in commercial quantities and at a price warranting extended experiment and use, the present field of application is as yet somewhat limited. But this field will rapidly widen with the cheapening of production, and at $1 per pound aluminum is already a serious competitor with both nickel and tin. Judging from the continual and rapid fall in price in the last 5 years, the lowest price is not yet, and we doubt not the example of the Cowles Co. will lead other active competitors to meet, or even cut below, the figure now given. With aluminum down to 50 cts. per pound the enormous industrial field now held by copper is open to the new metal on equal terms, for bulk for bulk it will be cheaper than copper.

Guard Rails for Bridges.

We publish on another page a communication as to bridge guard rails suggesting a type of protection which, if not absolutely novel, has as yet been but little used, and which will in consequence be naturally and properly looked upon with some preliminary skepticism. The query inevitably arises: Why is this type so little used? It is surely not so obscure in idea that it might not have occurred long ago to those who were studying how best to protect derailed cars from going through bridges. Is it not, therefore, probable that it was tried long ago, found defective and abandoned in favor of the present more usual plan, to be renewed from time to time as defective and exploded ideas often are?

These are questions we cannot answer, and we must confess to having been somewhat affected by them. It will not at all surprise us if the communication brings out evidence of prior trial of this device at various times and places, with unfavorable results which led to its abandonment. Not that such evidence, if brought forward, should be necessarily conclusive; far from it; but it would make it easier to understand why the plan has been neglected in the past.

Judging of the device itself, on its own merits, apart from the doubts suggested as to past experience, it would appear to be one of no little merit, combining as it does many of the merits of the Latimer rerailing type, and of the Jordan parallel guard type [ENG. NEWS, Aug. 16, 1890], while avoiding certain objections to each. It is an undoubted objection to the Latimer guard that it does not provide quite as effectually as might be desired for derailed cars which are more than half-gauge out, even in the so-called Childs-Latimer form of the guard which we have several times illustrated, and which provides by flaring outside guard rails for bringing the trucks back into position, and by collision posts for breaking couplings and wrecking on the solid, when cars are too far out for control. Keeping in view the many cases in which derailment is due to broken wheels, axles or trucks, it is open to legitimate question whether in such cases of large divergence from line it is not safer to merely keep the trucks where they are, and skid them over the bridge somehow, than to attempt to force them back into line as they enter the bridge, and so conceivably make a bad matter worse.

This is the theory on which the Jordan guard is designed and as we have often said, it is a theory of some force which may legitimitely be accepted, although we seriously question whether it is on the whole a proper theory to act on. An exceptional road like the Canada Southern, which is much less likely than most roads to have a derailment unless something breaks to cause it, may do so with more propriety; but as to such and all roads the question must arise: *How large a proportion* of derailments are in fact due to breakage, so that no rerailing device could be expected to be effective anyway? And as to this we published some important statistics in our issue above referred to [Aug. 16], which should be consulted by every one interested in the question, and which tend to show that derailments due to breakage are in all cases a small percentage of the whole.

It is an important merit of the guard suggested in another column, however, that it possesses, in nearly equal degree with the Jordan guard, the advantage of providing a skidway to carry broken parts safely over the bridge without catching in the floor or breaking further; while it avoids the serious defect of the Jordan guard, that it does nothing whatever to bring or keep the derailed cars within the limit of the bridge floor. In other words, the Jordan guard, to be reasonably effective, requires the bridge floor to be about three gauges wide, or 14 to 16 ft. If less than this, it leaves a certain proportion of the cars to topple over the side of the bridge floor anyway.

The Jordan device provides three parallel interior skids, about 12 ins. apart in the clear. The guard suggested elsewhere provides two interior skids, separated from the main rails and each other by successive clear intervals of 21½, 9 and 21½ ins. The difference in probable skidding efficiency is not great enough to prevent the peculiar feature of the latter guard from seeming a very important one: that it brings the wheels in to not over a half-gauge aberration, so that a floor only two guages wide is sufficient for safety unless the wheels prove wholly uncontrollable, which will rarely happen. Now, nearly all existing bridge floors are two gauges wide, while very few of them are three gauges wide.

Moreover, there is nothing to prevent placing Latimer rerailing frogs just in front of the device elsewhere illustrated, so as to rerail cars if they are sufficiently controllable, or if not, to guide trains into a position of merely comparative safety, half-gauge off. Used in this way the Latimer guards would be very simple and inexpensive additions, costing, say $25 per bridge in place.

In view of the fairly well established fact that in most derailments the wheels are near enough to their proper position to be rerailed by proper rerailing frogs, and that, in most of the remaining cases, the wheels are a full gauge off, less the thickness of the wheel, we hold that a proper regard for human life and property requires the use of rerailing guards of some kind at every bridge.

For not one scintilla of evidence exists, so far as known to this journal, that a single life or limb was ever lost by the use of such appliances which would have been saved by their absence. If this were otherwise, it would not follow that they should not be used, for there are few safeguards which do not at times, under peculiar circumstances, become sources of danger. It is sufficient to show that a device does decidedly more good than harm to warrant its use, and when it can be shown in addition that a given device never does become, or in long experience never has become, a source of danger, while often doing good, the case in favor of it becomes immensely stronger, and it is surely not necessary to establish that it is always effective to make its use obligatory on conscientious men. It is enough to show that it is generally effective, and reasonably cheap and durable.

Neither is it any excuse for hanging back and doing nothing in regard to bridge guards, that there is some difference of opinion as to what is the best form of bridge guards; as well say that there is excuse for not wearing any clothes because men differ as to the best color, cut and material; as well say that no man should ever eat because there is no hour of the day or night which millions of men are not agreed is precisely the wrong hour for eating meals. No one device can include all desirable qualities; some will prefer one and some another, from honest conviction. Taking all the possible combinations of timber and metal bridge guards, rerailing frogs, collision posts, spacing of ties, widths of floors, etc., etc., there are at least fifty different styles of complete floors having sufficient merit to make it pardonable for a careful and competent man to prefer them for his use, just as there are much more than fifty combinations of clothing styles or of meal hours which may reasonably find favor. There cannot in the nature of things be a large majority in favor of any one of these combinations. It is in no way an excuse for delay that there is only a minority in favor of any one of them. There is at this moment a large majority of the competent engineers of the country in favor of *some* plan of thorough protection of bridge floors. This should be and is enough to condemn any man who persists in holding back and doing nothing.

Finally, this truth should be kept in mind in all study of the bridge guard problem: In all derailments from whatever cause, the tendency is for the derailed wheels to drag along for a considerable distance (often for many miles, always for many yards or rods) within 6 to 18 ins. of the

rails. When the erratic tendency becomes so strong that they can no longer maintain this position, they stray off very rapidly from their original position until they come to a second holding place, which is when they are nearly gauge off, the inner wheel bearing against the outer rail. In about half the instances when wheels get so far off as this, the outer rail does not offer resistance enough to control them at all. In the remaining cases the outer rail does control them for a considerable distance, until there ceases to be adequate bearing for the outer wheels, when the final smash comes. If the problem be attentively considered from this p int of view, it becomes easie to see what kind of protection is likely to be most effective.

Notes in Buffalo.

[EDITORIAL CORRESPONDENCE.]

At the New York Car Wheel Works, a process is in use for cleaning car wheels as they come from the soaking pit, which deserves to be better known and more widely practiced. The process is simply an application of the sand blast. The wheel is rolled into a small chamber where it stands vertical. The tread rests on rollers which are moved by gearing, so that the wheel is slowly revolved without changing its position. A flue opening on one side of the chamber leads to a blower, which directs a current of air against the face of the wheel. Opening into this flue a short distance from the wheel chamber is a chute, leading to a bin containing cinders on the floor above.

The workman rolls the wheel into the chamber, closes the door, and by moving a lever turns on the air current, opens the cinder chute and starts the wheel revolving. About 20 seconds are sufficient to clean one face of the wheel, and it is then reversed to clean the other face. The cinders used are from the size of a grain of wheat upwards, and are used over and over again with very little wear, a belt elevator, such as is used in grist mills, taking them from beneath the wheel chamber to the floor above. From the top of the wheel chamber a flue leads to a dust chamber, and the current of air blows all the lighter particles over into it, thus avoiding most of the dust which would otherwise arise. With this apparatus one man cleans 200 wheels in 3½ hours-including the time taken in rolling them to and from the machine. The cleaning is done better than by hand labor and at much less expense.

Jib cranes are used in the foundry, driven by a line of shafting carrying bevel gear wheels, which drive a vertical shaft centered in the mast of each crane. This is claimed to be a superior arrangement for a foundry where dust is everywhere, since the wearing parts are few and cheap.

In a shop near the foundry are the grinding lathes for machining car wheels. This process is meeting with especial favor among the builders of electric railway cars; but a very considerable proportion of the output of ordinary car wheels are now finished by the process. A full account of this process was given in ENGINEERING NEWS July 12, 1890.

THE GOULD COUPLER COMPANY.

Very encouraging reports of the progress of the M. C. B. coupler are given by this company. About 50,000 M. C. B. couplers of the Gould type are said to have been applied in the past twelve months.

The company contracts with malleable iron makers for the manufacture of its couplers, and a system of tests has been devised to keep the contractors' work up to the specifications. A large tensile testing machine has been put in, and also a drop test with a 1,000 lb. weight, thus closely imitating the rude buffing strains which are the chief cause of breakages. In experimenting with steel knuckles some were tried of Hadfield (English) steel, but were found to give less favorable results under the buffing test than knuckles made of American steel. Besides the tests for strength, all couplers are carefully tested by standard templates before shipment.

THE BUFFALO FORGE COMPANY.

A considerable part of the work turned out by this company now consists of heating plants working on the forced draught system. The public were slow to appreciate the merits of this system when it was first introduced, but the performance of the first plants erected was so satisfactory that it is now claimed to be one of the most popular methods of heating in use, and is still increasing in favor as the importance of the thorough ventilation which is possible with it is more appreciated.

The testing of the blowers for accurate balance is an interesting process. The blower is set on the floor and run at high speed with the air inlet closed. If out of balance its vibration very quickly indicates the fact, and the workman adjusts it until the vibration ceases.

The hand blower is evidently bound to displace the old leather bellows in even the most backwood country blacksmith's shop. Over 30,000 portable forges with hand blowers have been made by this company alone.

CASTING A SCREW THREAD.

The Howard Iron Works, of Buffalo, make quite a specialty of elevator machinery. The machinery for the New York Central's new elevator at New York city, built to replace the one burned several months ago, and for the West Shore's new elevator at Buffalo, now under construction, comes from these works. To carry the long line shaft, which transmits power from the main engine along the length of the building, a hanger has been devised which can be adjusted by a heavy screw in the base to bring the shaft into accurate line. To cut the internal thread for this screw on the inside of the cored hole in the base casting was very expensive, and the attempt was made to cast the screw thread in the piece. This has worked very well. The thread is a coarse square one, and the shaft which engages with it is about 2½ ins. in diameter.

CORRESPONDENCE.

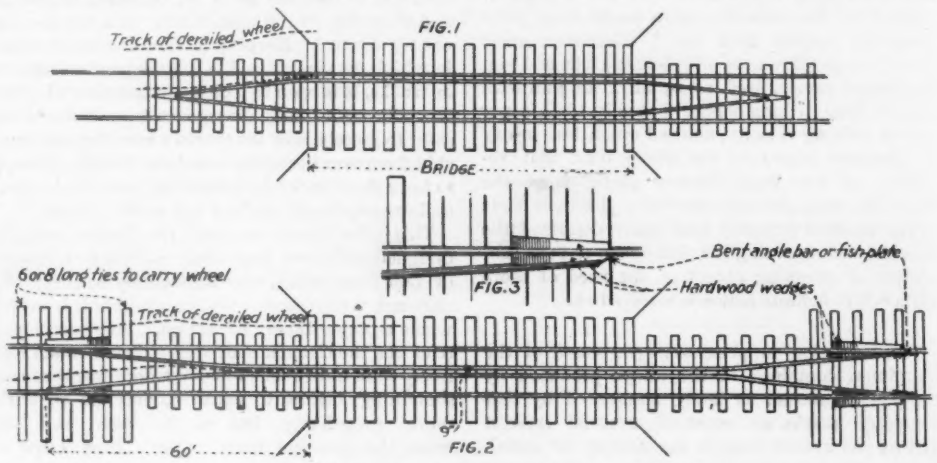
Safety Guard Rails on Bridges.

PROVIDENCE, R. I., Sept. 4, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I have read carefully your various articles on guard rails for bridges and feel that something better must take their place to give some assurance of safety to bridge and train in the worst possible case of derailment. Toward arriving at this, I would ask your criticism of the following comparison of the device now generally used (Fig. 1) and that suggested below (Figs. 2, 3).

I think you will agree with me that the device generally used is only good for *favorable* cases of derailment, and is almost criminally defective in case of a bad derailment, where the derailed wheel has just passed beyond the center of the track and after that is guided outwardly to certain destruction; for there are very few bridge floors wide enough to carry the outer wheel, and nearly all through bridges would be demolished as well as the train.



ARRANGEMENT OF GUARD RAILS ON BRIDGES.

Fig. 1 shows a possible and very probable case of derailment by dotted lines. To make a bridge to carry this derailed train would require a floor width of about 5 ft. beyond the outer rails on each side, or about 15 ft. for single track bridges and trestles, with, say, 13 ft. added for double track. How many bridges are there in use to-day that will do this? I know of only one; that is at Quinsigamond, Mass., on the Worcester Division of the New York, Providence & Boston R. R., which has just been constructed with a floor 5 ft. clear width outside of main rails, with wooden guards outside of that.

Bridges with the arrangements of Fig. 1 without a floor wide enough to carry train derailed as shown are almost criminally dangerous.

The following sketch shows guard rails in a position of almost *absolute* safety, and to which I see no serious objection. The expense is very little more than that for the device now used, and it certainly increases the safety of bridge and train to twice that of the other, as nearly all bridges, through and deck, on standard roads, are at present capable of carrying the derailed train over safely. It has also the good quality of acting as a protection or skid to broken parts under the wheels, as claimed for the Jordan device. A rerailing device to act *after* the wheels have passed over the bridge is also included, as shown in detail in Fig. 3, but it acts only on wheels derailed on the bridge.

The directing guard rails in Fig. 2 should be at least 60 ft. long, so as to give a gentle change of direction to the wheels. Ties long enough to carry the outer wheel should be placed at the ends of the guard rails

This device only requires a bridge floor extending outward 3 ft. beyond the outer rails on each side, or 11 ft. for single track bridges. If a 6-in. wooden guard were placed outside of this it would need to have a width of 12 ft., which, I believe, is about the standard used in first class work. Double tracks should be 13 ft. between centers for a train on one track to clear with certainty a derailed train on the other track. This is the standard distance on all new work on the N. Y., B. & P. R. R., and most other roads. Very probably, to judge from your account lately [Aug. 23, 1890] of the "Knocked Down" bridge on the Baltimore & Ohio R. R. if the above arrangement (Figs. 2, 3) had been used the bridge would have been saved from censure. The same might be said of most "knocked down" bridges and of trains tumbling off trestles, especially where such structures occur at or near sharp curves. If there is nothing to guide a train over a bridge in case of favorable or very bad derailment, it is certain to come to grief along with the bridge; then the bridge gets the blame. I say, give the bridges a fair show by putting on proper guard rails, such as Fig. 2 or a better device, instead of the guard (?) rails now used, and in almost every case the bridge will do its duty.

J. A. MCNICOL,
Bridge Engineer N. Y., P. & B. R. R.

[We have briefly discussed the questions raised in this communication on another page.—ED. ENG-NEWS.]

Cement Tests.

FORT MONTGOMERY, N. Y., Sept. 24, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In your issue of Sept. 20 I notice a letter from JOHN K. LLOYD, Esq., of Batavia, N. Y., on "Cement Tests."

The difficulty he complains of I have experienced myself, causing great annoyance. As an experiment I placed pieces of thin cardboard between the points of the clip and the briquette, which entirely remedied the evil. I have had no trouble since. I use Richle Bros.' machine.

GEO. C. DICKINSON.

State Supervision of Dams and Reservoirs.

TROY, N. Y., Sept. 30, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: There has been considerable discussion, lately, in this country, about the advisability of subjecting highway bridges to the inspection of engineers appointed by the State, and the matter has been referred to quite often in ENGINEERING NEWS and other technical journals. The advantage to be derived from some such inspection has lately been forcibly called to the writer's attention by a case occurring in this State, in which reports made by him and others on the condition of a recently finished highway bridge resulted in the restitution to the counties interested of about 21% of the already paid contract price.

It is desirable, however, to call attention, not less frequently, to a still more serious cause of danger to life and property due to the improper construction of another class of structures, viz., the dams of storage reservoirs. It was the business of the writer recently to report on the cause of breakage of a dam whose rupture resulted in the destruction of roads and farm lands for a distance of five

or six miles from its site, though, fortunately, and rather remarkably, no loss of life occurred. It was the old story of the earth dam with no waste weir; and it is the object of this communication to express the decided opinion—which will be concurred in, I think, by most engineers—that this class of structures, second only in importance to railroad bridges in the aggregate damage caused by their failure, should be subject to proper supervision and inspection, such as is exercised, for instance, in Connecticut by the Commissioner of Dams and Reservoirs.

PALMER C. RICKETTS.

The Red Rock Cantilever Bridge.

(WITH INSET.)

The cantilever recently completed over the Colorado River, known as the "Red Rock Cantilever," of which we published foundation details last week, is the largest structure of the cantilever type in the United States. The bridge is owned and operated by the Atlantic & Pacific R. R. (a part of the Santa Fé system), and crosses the Colorado River about 13 miles below The Needles, Cal., as shown in the map herewith. The railway originally crossed the river some 9 miles higher up, on a low bridge consisting of a large number of wooden spans of about 80 ft. each, supported on wooden piles; but as this bridge was constantly being damaged and partially washed away by freshets, and the embankment approach on the Arizona side was also subject to bad washouts, owing to the grade being below high-water mark for some distance, it was finally decided to change the location of the line to higher ground and build an entirely new bridge. The line was therefore carried down the California shore with a slightly ascending grade, until at the proposed site for the new bridge it was about 45 ft. above extreme high water, and thus well out of danger from such source.

The new location on this route was somewhat longer than the original line, but was so located as to cross the river at its narrowest point.

The site of the bridge is very well suited for crossing, as at this point the river is not over 850 ft. wide at ordinary stages of water, and the banks rise abruptly to an elevation of about 85 ft. above low water, at which elevation the grade crosses.

It was the original intention to put in a through channel span of 396 ft., with two deck spans of 195 ft., and bids were asked on this plan. This location was made by and the whole work done under the general supervision of SAM'L M. ROWE, Chief Engineer, A. & P. R. R.

The contract for superstructure on this plan was let to the Phœnix Bridge Co., in December, 1888, but before any work had been done it was found that a satisfactory bottom could not be procured in these positions, and, after careful soundings had been made, it was finally determined to place only two piers in the river, near the shores. Also owing to the very swift current at this point, the constantly changing bottom, and the great danger of sudden freshets, it was considered inadvisable to place false-work in mid-stream, and the cantilever type was determined upon. The foundations we have already fully described.

The contract for superstructure was let to the Phœnix Bridge Co., on their own designs, in January, 1889, and work was commenced thereon immediately, the contractors for substructure being Sooysmith & Co., of New York, as noted last week.

Owing to delays in placing the piers, caused by the unexpected depth of the foundations, work on the superstructure was stopped about March 1, and not resumed till the following October, which accounts for the apparently long interval between the awarding of contract and completion of bridge. The structure is a single track through cantilever of 990 ft. over all, divided as follows:

2 anchor arms, 6 panels, each 27 ft. 6 ins. = 165 ft.	330 ft.
2 lever arms, 6 panels, each 27 ft. 6 ins. = 165 ft.	330 "
1 suspended span, 12 panels, each 27 ft. 6 ins. = 330 ft.	330 "
Total	990 ft.

This structure is approached on east end by a plate girder viaduct of 4 spans of 30 ft. each, making 1,110 ft. for the total length of crossing. The trusses are 25 ft. center to center, and the depth of the suspended span is 55 ft., which increases to 101 ft. over the main pier.

These general dimensions are shown on the outline diagram published last week. It will at once be seen that the ratio of anchor to lever arms is not that of maximum economy, but the distance between the main piers was fixed by the nature of the bottom, and the length of the west anchor arm could not have been increased without considerable excavation of the bank. This division was therefore adopted.

The main pedestals were set just above high water, and the clear height under suspended span was 41 ft. above high water, giving sufficient head room for any river traffic which could occur.

The designs were made under the specifications of the Phœnix Bridge Co., as modified by Prof. S. W. ROBINSON, Consulting Engineer A. & P. R. R.; the trusses of the structure being entirely of steel, while the floor and lateral bracing were of iron.

The structure was to carry 2 ten-wheel engines and a uniform load of the weights and dimensions shown in Fig. 2; the allowable unit stresses in no case to exceed the following values for steel members:

Long verticals, 9,200 lbs. per sq. in.

Main diagonals, 12,300 lbs. per sq. in. for spans under 200 ft.

Main diagonals, $9{,}400\left(1+\frac{\text{min. stress}}{\text{max. stress}}\right)$ lbs. per sq. in. for spans over 200 ft.

Compression members $P = 1 + \frac{\frac{10{,}000}{l^2}}{\frac{40{,}000}{r^2}}$ for flat ends.

Compression members $P = 1 + \frac{\frac{9{,}730}{l^2}}{\frac{30{,}000}{r^2}}$ for pin ends.

The quality of materials was that required by the Phœnix Bridge Co.'s standard specifications, and sufficient tests were made, both of prepared test pieces and full-sized members, to insure the quality of all materials used being within such specifications.

In making the stress sheets particular attention was given to the effect of the wind, which was taken at 30 lbs. per sq. ft.; and not only was its direct effect taken into account, but also the overturning effect on both trusses and train. All stresses in the structure caused by wind during erection were fully provided for.

The wind bracing was so designed that the entire wind pressure on the suspended span was carried to the lower chord of the lever arm (that from the upper chord of the suspended span traveling through the portal bracing at ends of such span) and then carried by the lower lever arm bracing.

The lower anchor arm bracing was figured to carry the stresses arising from considering it either as a simply supported span or as the anchor arm carrying the negative reaction from the pressure on lever arm and suspended span. The lower bracing in both anchor and lever arms was composed of stiff members, while the upper bracing was of rods and struts. In the suspended span all bracing was of rods and struts.

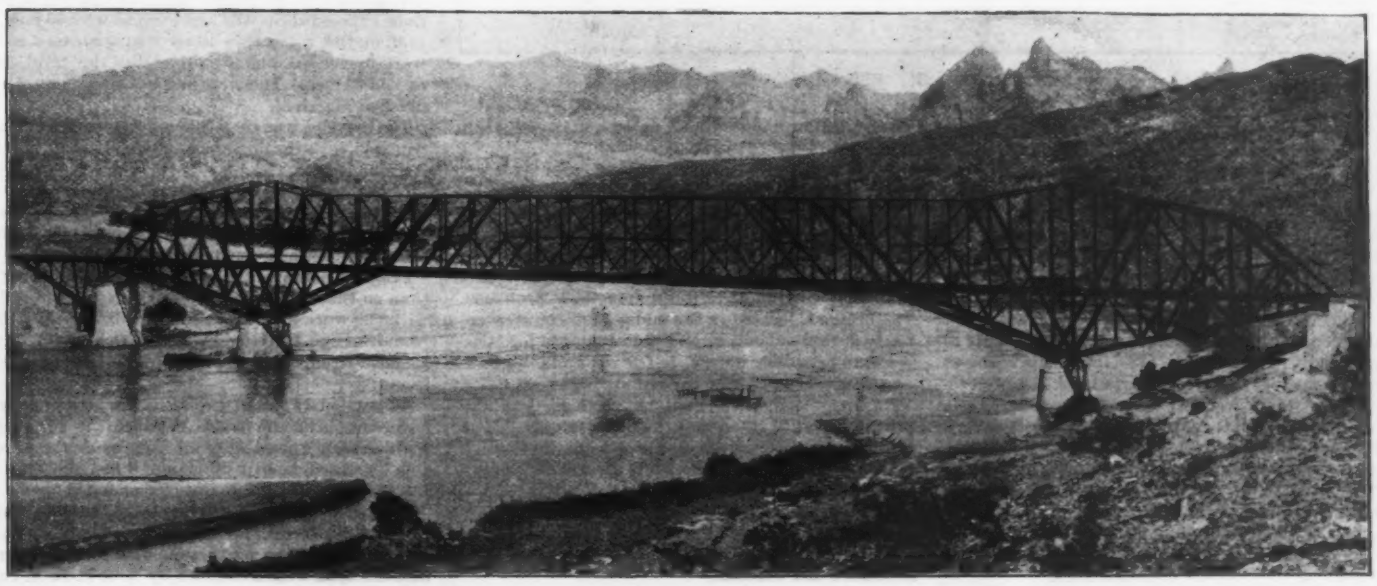
Transverse bracing was placed under each floor-beam of the anchor and lever arms to carry the wind pressure against the train and floor to the lower lateral system, and the main posts were strengthened where required to resist the bending due to wind.

The two anchorages (shown on inset and in Fig. 3) were somewhat different, as on the east shore the concrete pier was not built within 14 ft. 6 ins. of the main anchor pier (sufficient weight for anchorage being attained at that point), and the end of the anchor arm was supported by an iron bent, as shown. This bent was not required for the vertical loading, as, owing to the shortness of the anchor arm, there was tension in the anchor arm end post and anchorage bars under all conditions of loading; but for lateral anchorage, as well as for convenience in erection, it was necessary.

By examining Fig. 3 it will be seen that while the check boxes allow a small vertical motion, due to the stretch and expansion and contraction of the anchorage bars, yet they hold the end of the span firmly against lateral deviation.

The west anchorage is similar to that at the east end, except that the bent is omitted and the end floor beam is directly anchored laterally to the masonry.

The adjusting wedges are shown on the inset, from which it will be seen that driving the lower wedges lengthens the lower chord and raises the projecting end of the span during erection; while driving the upper wedge shortens that chord and again raises the end of the span.



VIEW OF RED ROCK CANTILEVER BRIDGE FROM NORTHWEST.

Owing to the enormous pressure which these wedges had to support, it was found impracticable to put in the requisite amount of roller bearing, and flat surfaces were therefore used. The maximum pressure between these bearing surfaces was taken at 1,300 lbs. per sq. in., and they were found to work with entire satisfaction. It will be noticed that the slope of the wedges is only 1 in 12, and they were so designed to be readily driven under their maximum pressure in case an elongation of the suspended span or an elevation of its outer end necessitated such a movement. The wedges were, however, set so far in that there was no probability of the ends of the span coming too low or too short for connection, and the only movement required was that of withdrawing the wedges. It was found with the above slope the pressure was not quite sufficient to remove the wedges, and they had to be partially raised by means of the upper screws shown on the drawings.

It will be noticed that the upper wedge is only 20 ins. wide, while the lower is 30 ins. This is due to the fact that all the erection wind stresses are carried by the lower wedges, and after combining the effect of wind with the erection stress the 2 wedges will be found to carry the same pressure per square inch. The maximum load on each main pedestal was 2,100,000 lbs., and as the pressure allowed on masonry was limited to 275 lbs. per sq. in., a pedestal was placed under each shoe, giving a square base of 7 ft. 3 ins. on each side, and by means of vertical ribs distributing the pressure over this area.

The floor system, as already stated, was entirely of iron, and all floor beams were riveted between posts. In the anchor and lever arms the stringers were riveted between floor beams, while in the suspended span they stood on brackets, on account of the lower chord erection stresses in this latter portion of the structure being compressive, while the final stresses are tensile, which change would have loosened a riveted connection.

Slotted holes were placed in both the upper and lower struts connecting the suspended span and lever arm and the stringers in this panel rested in pockets to allow for expansion and contraction.

The lower laterals in the panel *A* (see details of lever arm on inset) were connected to the chord member *A* only, and since there was no chord stress in this panel after erection, due to the wind pressure, it was only necessary to transfer the shear to *B*. This was done by making chord *B* fit closely within chord *A* (sliding longitudinally with expansion and contraction), and thus by actual contact the shear is carried from one panel to the other. The accompanying stress sheets and detail drawings on the inset give all the main sections and arrangement of joints, and further description is hardly necessary. One noticeable detail is the combination of stiff members and bars in the anchor arm end posts and upper chords. This is due to the fact that the stresses in these members (from the completed structure) are invariably tensile; and, while these members had to be stiffened for erection purposes, it was deemed unnecessary to make the entire member stiff, as the loss in such case from rivet holes was quite considerable, and the combination member was consequently used. The main difficulty in designing the structure was the arrangement of the enormously large sections, which are larger than any bridge members heretofore used in this country, the main pedestal pins of 15 ins. diameter being quite extraordinary.

The entire superstructure was designed, constructed and erected by the Phœnix Bridge Co., and the special attention which such unusual connections required was given to them, so that each joint was as carefully computed and designed as the main members.

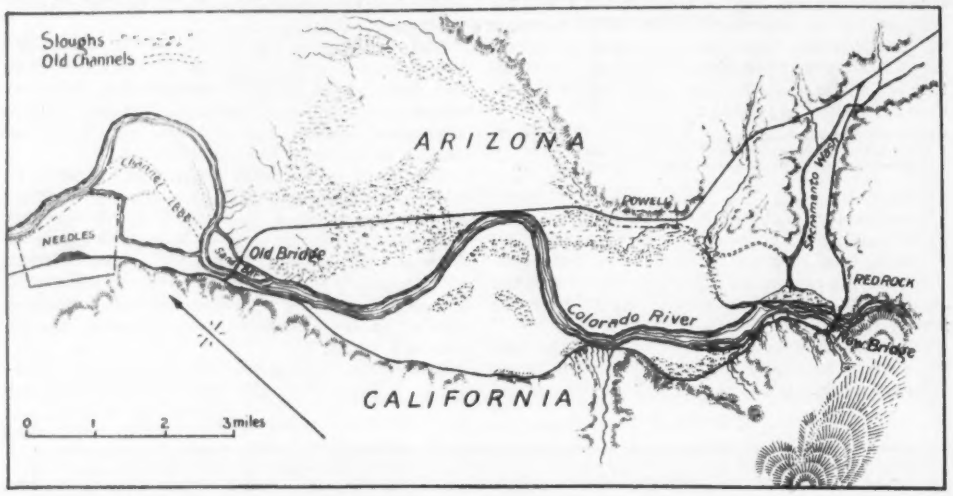


FIG. 1.—MAP SHOWING LOCATION OF RED ROCK CANTILEVER BRIDGE.

The entire weight of iron and steel in the structure was 3,500,000 lbs., and it was found to vary in no case more than 2 per cent. from the assumed dead weight, which dead weight in the anchor and lever arms was assumed to vary with the depth.

The erection of this structure was one of special interest, bringing up as it did many new problems. The bridge is located in the midst of a country entirely devoid of timber, and that required for falsework and traveler was cut in Oregon and shipped to San Diego, Cal., thence carried by rail to the site. This Oregon pine, while not as good as Southern pine, was found to answer the purpose well. There being no means of boarding or lodging in the vicinity, it was necessary to build a camp and provide for all men at the site.

Twenty men were sent out the latter part of December, 1889, to build the necessary camp buildings, erect unloading derricks and start the anchor span falsework and traveler.

This falsework was of the ordinary type, 6 legs to each bent placed directly under the panel points, caps being on the same grade as the lower chord of truss and some 3 ft. below it. This falsework was erected and placed in position in the usual manner by balance beams projecting from the finished portion.

The next step was the erection of a large traveler, the design of which is believed to be quite original. As may be seen by examining the elevation of the bridge, published last week; it is a through cantilever, and the second one of this type erected. This made it necessary to design a traveler to run on tracks at the same level as the base of the rail and inside of the trusses, the top of the traveler extending some 10 ft. above the highest point of the truss and the forward portion projecting about two panel lengths ahead of the front supporting wheels. This traveler is shown in Fig. 4, and when fully rigged carried 3 hoisting engines with 4 spools on each. The traveler was a rigid one and very convenient for erectors in making connections above the base of the rail and in moving about from point to point. It was also easily moved on rails from panel to panel.

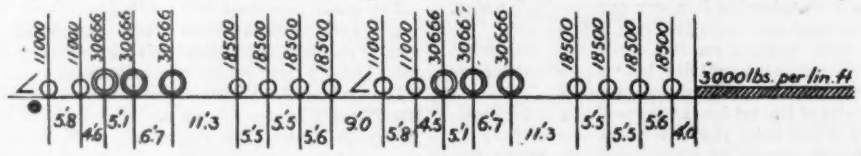


FIG. 2.—LOAD DIAGRAM.

The traveler ran on stringers placed on top of the floor beams directly under the traveler legs. These stringers were the regular railway stringers re-enforced, and were afterward used in the structure.

The falsework and traveler were ready to receive iron about Jan. 15, 1890. The necessary material, however, did not arrive until Feb. 4, 1890, when the actual erection of trusses began.

The first iron placed in position being the pedestals and shoes on the west river pier, the sections of lower chord were then placed by a small *A* traveler, beginning at the pier and extending to the anchorage, where the end web members of the trusses were placed in position by the large traveler and connection with the anchor bars in the west anchorage made.

From this point on the large traveler did all the work and, after raising and connecting 2 panels of the truss complete, was moved ahead until the front wheels were over the end of structure finished.

Iron and material were delivered to the traveler on "dolly" cars running on regular track; this car being run out to the end of the finished portion at the foot of the inclined overhanging boom of the traveler, where a set of blocks hung to the center of the top caps took hold of the material, hoisting it free from the cars and ahead to other blocks until clear of the inclined boom, when it was caught by blocks hung to the ends of the caps, directly over the center line of the trusses, swung to one side and passed back to the proper point and placed in position. The erection was first started with 56 men, all told, on the rolls; this force was increased as the work proceeded, but at no time did the total force exceed 96 men. The west half of the structure was finished March 24.

The traveler was then taken down in 4 days and removed with the entire camp outfit to the east or Arizona side.

In the meantime falsework had been erected for the east anchor arm, and the large traveler was in position and again ready for work on April 8, when construction was immediately begun.

Progress made on the east half was much better than on the west side, the men being more familiar with the work and owing to there being no delays from iron not arriving in time. On May 7 "iron touched iron," and the work of final connection began.

As previously stated, the wedges in both upper and lower chords of the panels between the suspended span and lever arms were set to provide for a probable increased length of span of 6 ins. and also an extra elevation of the center of suspended span.

The deflection of the end under the traveler, which weighed 240,000 lbs., fully rigged, was only 3½ ins., and much less than was assumed. It was also found that the span length as given by A. & P. R. R. engineers agreed within a small fraction of an inch, so that wedges were set much farther in than was necessary.

As soon as the "iron touched" the work of slacking off the wedges began and continued until the last pin was driven on May 8, 1890, and the center span swung free on the suspenders. All iron settled to its place without a hitch of any kind.

Owing to a washout, which occurred May 9, on the line of the A. & P. R.R., completely stopping all traffic, orders were given at once to put the structure in order to carry trains, and after the lower panel of the transverse bracing and the lower engine were removed from the traveler cars were allowed to pass, on May 10, 1890. The structure carried the load of the traveler, in addition to the train, without showing any signs of weakness or lack of stiffness. After the traveler was entirely removed a test of the structure was made by Mr. R. D. Rowe, of the A. & P. R. R. engineering force, with the following results.

With a load of 2 ten-wheel engines weighing 91 tons each, and a train of loaded 34-ft coal cars, weighing 31½ tons each, reaching from main pier to main pier (anchor arms not loaded), and calculated

to be about 70 per cent. of the maximum load specified, the deflections were as follows:

Center of suspended span	3.40 ins.
Ends of suspended span	1.95 ins.
Over main pier	0.012 ins.
Rise at east anchorage	0 156 ins.

Observations were taken over floor beams, anchor arms loaded with same load:

Rise at center suspended span	0.34 ins.
" " ends " "	0.22 ins.

To summarize: A structure 1,100 ft. long, weighing some three and a half million pounds, the largest of its type in the United States, was erected in 80 working days with an average force of not over 75 men. The details of the structure were so carefully worked out and the shop work so perfect that without any previous assembling it fitted perfectly in the field.

The cost of the substructure was $232,300, of the superstructure $230,100, making the total cost $462,400. The total expenditure for bridge, piers and approaches up to June 1, 1890, was as follows: Labor, $227,404; timber, $22,420; iron and steel, $218,209; piling, $11,032; tools, $10,210; fuel and water, $10,313; cement, $21,965; cross ties, $16,800; rails, $30,100; track material, $10,542; freight, $61,366; locomotive and train service, $8,373; soundings, $7,809; tramways, $13,552; demurrage, $900; engineering, $24,000; total, $695,115. The estimate made in June, 1889, was $695,136—$21 more than the actual outlay. This is remarkably close calculation. For a number of the photographs and drawings accompanying this article we are indebted to Mr. R. D. ROWE, Assist. Eng., Atchison, Topeka & Santa Fé R. R.

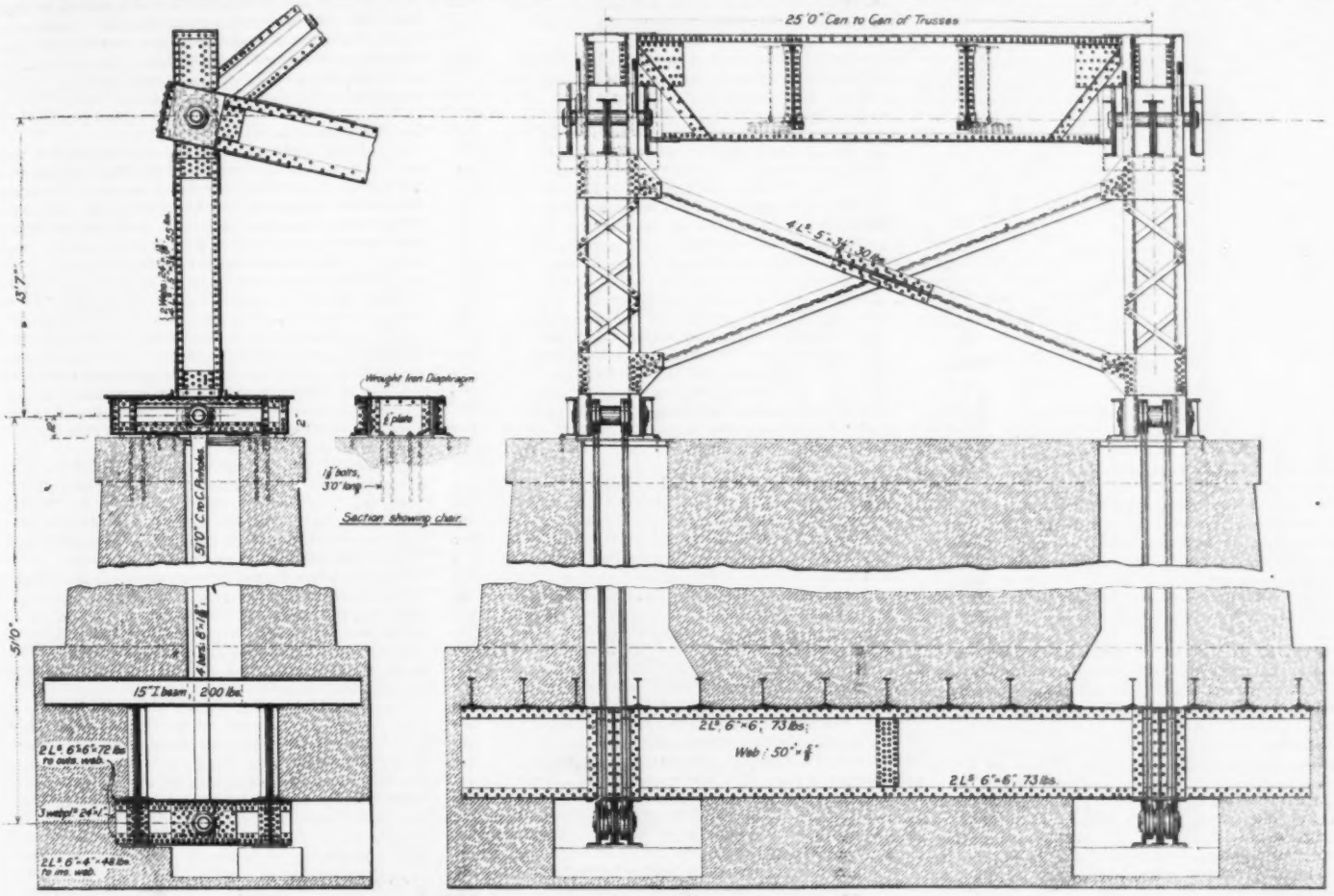
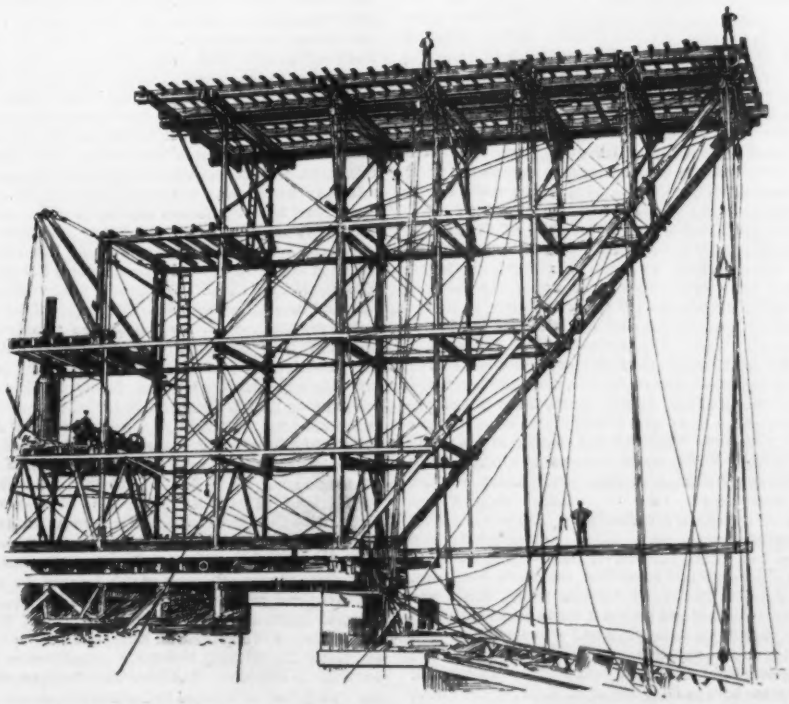

25'0" Ctrs to Ctrs of Trusses
Wrought Iron Diaphragm
Section showing chair.
15" I beam, 200 lbs.
2 Lgs 6"x6"x 73 lbs
Web 50"x ⅜"
2 Lgs 6"x6" 73 lbs.

FIG. 3.—EAST ANCHORAGE, RED ROCK BRIDGE.



SKETCH OF TRAVELER USED IN CONSTRUCTING RED ROCK BRIDGE.

The designer of the bridge was Prof. J. A. L. WADDELL, of Kansas City, Mo., and the Consulting Engineer, Prof. S. W. ROBINSON, of Columbus, O. The Phœnix Bridge Co. was given every facility and assistance possible by Mr. SAM'L M. ROWE, Chief Engineer, and other officers of the railroad, including Mr. R. W. HILDRETH, the Inspecting Engineer.

Alexander Lyman Holley.

We regret that we are unable to find space for the full text of this interesting address on one of the most gifted and brilliant of American engineers. We reprint verbatim, however, its most important passages. Mr. DREDGE first briefly adverted upon the circumstances under which he came to undertake to prepare the address, reading two interesting and appreciative letters, from Mr. JAS. FORREST, Secretary of the Institution of Civil Engineers, and from Sir HENRY BESSEMER. The last is of such interest that we reprint it in full:

DENMARK HILL, SURREY, Aug. 1, 1890.

Dear Mr. DREDGE:—The engineers of the United States having done you the honor to invite you to New York for the purpose of unveiling the statue of your old and esteemed friend ALEXANDER L. HOLLEY, it has occurred to me that this occasion presents an opportunity of which, with your kind permission, I am most anxious to avail myself.

You are aware that the civil, mechanical and mining engineers of America have invited the members of the Iron and Steel Institute to visit their country, and with more than their usual generous hospitality have provided a most interesting and extensive programme for their mental and physical enjoyment.

It is a source of very great regret and disappointment

Abstract of inaugural address of the HOLLEY memorial statue, by JAMES DREDGE, Editor of *Engineering*, Honorary Member of the American Society of Mechanical Engineers.

to me that nature has interposed an insuperable barrier between us, by giving me a constitution that does not permit me to make the shortest sea voyage without absolute danger to life; but for this circumstance, the fact of my being in my seventy eighth year would not have prevented me from accepting their generous hospitality, and seeing with my own eyes the enormous progress which the indomitable energy and perseverance of the citizens of the New World have made within the last twenty years.

Much as I should have felt interested and impressed with their great mechanical and engineering progress, I should have experienced still greater pleasure and pride in visiting their magnificent steel works and seeing the material that bears my name produced on a scale of greater magnitude than it is in any other country in the world. And when I reflect on the great honor conferred on me by this appreciation of my labors, I find it difficult to express the gratification it has afforded me.

In England, France and Germany many generous tributes have been accorded me by imperial personages, corporate bodies and scientific institutions; from the nature of her constitution, America has no orders of knighthood or other titles to bestow. But to a generous people a way may always be found of honoring those whom they desire to honor, and in giving the name of Bessemer to a rising city in the United States they have created a living monument to my memory that will last for centuries after all the titles and medals I have received in Europe have passed away and been forgotten. It is in vain I look for words adequately to express my gratitude for this great memorial, but I gladly avail myself of this opportunity of thanking them, though but very feebly, for the honor done me, which far exceeds in generosity and value anything which my invention deserves.

It has been suggested to me that the Society of Mechanical Engineers of America would still further honor me by accepting my portrait; this I now send you, and I beg you to present it to them in my name, and at the same time to express the gratification its acceptance will afford me. Thanking you in advance for the trouble I am giving you, I remain, dear Mr. DREDGE.

Yours faithfully, HENRY BESSEMER.

Mr. DREDGE continued:

If I were able to do justice to the theme, I believe that there are few persons who have such good cause to speak with feeling and with eloquence upon it as myself. You will understand why, presently, if I succeed in making clear to you how deeply I am indebted to HOLLEY; how great his influence for good has been upon my character and whole career. If I succeed in making you understand this, you will understand also why my admiration for him is so largely blended with reverence, and my affection with gratitude. My whole career has been strangely influenced and moulded upon those of HOLLEY and the brilliant friend and companion of his early years, ZERAH COLBURN.

The course of ALEXANDER HOLLEY'S early years and education resembled those of most other well-born youths of the same period. He was the offspring of a union between the representatives of two old New England families that had taken root and flourished for many generations in Connecticut since they were transplanted from English soil. Deprived, almost from the day he saw the light, of a mother's care, he was fortunate enough to have that want supplied by the second marriage of his father, and the influences of the simple, rigid and God-fearing domestic circle in which his earliest years were passed, nourished the noble impulses and high principles that were born in him, and strengthened them so that they remained with him through life. He passed from the little district school to the local academy in Salisbury, thence to another in Farmington; from Farmington to Stockbridge, and from Stockbridge to Bridgeport, that he might prepare for Yale College. He did not commence his college career until 1850, when he was 18 years old, so that his education, which had been carefully superintended by his father, was more than usually thorough and complete. Yale College did not have the honor of inscribing his name upon her books, because in 1850 the Brown University at Providence had founded a scientific chair, and it was determined that HOLLEY should go there instead of to New Haven. After three years of college, HOLLEY was well fitted to commence the battle of life. Twenty-one years of age, wondrously winning in manners and appearance, with a fine constitution and indomitable energy, he was, indeed, well adapted physically for the struggle. And still more so intellectually. The strong natural bent of his character had been carefully strengthened and trained by himself from very early years. The influences of home were deeply rooted; his powerful memory and almost limitless capacity for observation had been developed by habitual and constant use. By nature he was an excellent draughtsman, and also by nature he had the power of language; hence from a very early age he had a facile and rapid pencil, a keen and eloquent tongue. He was a leader in youthful debate, an acknowledged chief in college journalism. The boy was father to the man, and the engineering instinct strong within him had shown itself almost from the first dawn of his intelligence. Mechanics, the design of machinery, and especially everything that had to do with locomotive engineering, gradually took the first place in his mind almost to the exclusion of collegiate subjects, and he made his start in the world in the shops of Messrs. Corliss & Nightingale, at Providence. There he served with credit as draughtsman, mechanic, engine-driver and inventor, and it is a remarkable testimony to his great ability at that time that, without any special preliminary technical training, Messrs. Corliss & Nightingale parted from him regretfully and at his own wish because he preferred to devote himself to locomotive design and construction rather than to that of stationary engines. With only 18 months' practical experience, HOLLEY started out in search of employment in locomotive works. It was natural enough for him to meet with failure and disappointment; after about a month he fell into despair. "I am ready to sink," he said, "for if there is anything certain in this world it is that I will never do anything but just this one thing, namely, build locomotives." Soon fate was kind and found employment for him in the locomotive works of Jersey City, where he remained long enough to gain valuable practical experience and to convince all those about him of his great ability and energy. But his dream of always building locomotives for a living was to be a short one.

A young man of his own age and of brilliant genius had, while HOLLEY was receiving his education, raised himself from the menial life of a farmer's boy to that of the superintendent of the New Jersey Locomotive Works, and had quitted it before HOLLEY had found the situation he was so anxiously seeking. Without education, this man had already come to the front as engineer and author; at 15 years of age he had secured publication for a series of "Monthly Mechanical Tracts," which he issued at Lowell in 1847. Humble as was his origin, his uncle had, years before his birth, brought the name he was to bear into notoriety, and the famous calculating boy, ZERAH COLBURN, was the object of wonder in scientific circles both in Europe and America. Beyond a natural gift of rapid calculation the uncle possessed no marked ability, while the nephew, less endowed as a mathematician, was in other respects probably the most marvelous member of the engineering profession of any country. A writer on mechanics at the age of 15, the superintendent of an important locomotive works at 20—and this without any technical training except what could be gathered while he labored for his scanty living—ZERAH COLBURN at 21 commenced the career for which he was best adapted, and became editor of the mechanical department of the *American Railroad Journal* in 1852. Of course he soon abandoned this position, and the following year undertook as his own property the New York *Railroad Gazette*. He was pushing the fortunes of this venture with that ferocious energy characteristic of the man at the time when HOLLEY obtained the situation he had been seeking; doubtless the chief talk in the works was of the late superintendent's newspaper, and we may be certain that COLBURN was often at the locomotive shops, getting information and seeking new subscribers. It seems but a poor little sheet now, that New York *Railroad Gazette*, for technical journalism has kept well to the front with the rapid and triumphant forward march of the engineer; but to me those flimsy pages are full of the deepest interest from their being the first effort of a man who was certainly the ablest technical journalist we have ever seen. So it was through the means of this paper that HOLLEY and COLBURN first met, and for some years they were destined to tread together the upward path to fame.

I have said that the most boyish letters and essays of HOLLEY showed gleams of literary talent which time and education kindled into a bright flame. In many respects the tastes, aims and ambitions of the two young men were similar. HOLLEY had already realized the pleasure of seeing his work in print and of being paid for that work; when he was 18 years of age he had written quite a remarkable treatise on cutlery which had appeared in *Poor's Railway Journal* in 1850. It followed, as a matter of course, that he was as eager to write for COLBURN'S *Gazette* as COLBURN was to obtain the assistance of such a congenial contributor. So in a short time the relations between the two drew closer, and HOLLEY and COLBURN entered into partnership, editing the little sheet conjointly. It was not long before a marked success attended their efforts; then COLBURN wearied of the work, and in 1856 sold his share to HOLLEY and emigrated to Iowa, where he bought land with the proceeds of the sale, in obedience apparently to some passing fancy that prompted him for the moment to turn his hand to farming. For a year longer the paper under the changed name of *Holley's Railroad Advocate* did fairly well; the new proprietor bore the business and editorial burden of the undertaking more systematically than COLBURN, I am sure, but not with the same degree of feverish energy which COLBURN always brought for a time into every new scheme he took in hand. In 1857 a great wave of commercial disaster swept over the country and engulfed the *Railroad Advocate*. COLBURN had wearied of Iowa and returned to New York, where he and HOLLEY, on the ruins of the paper, started another journalistic venture which lived for two or three months as *Holley and Colburn's American Engineer*. Brief and unsatisfactory as these experiments in journalism had been, they nevertheless were attended with the most useful and important results to both men. They had lived by their pens for two years, which was no small matter; they had gained a vast amount of experience of a varied character; they had of necessity come in contact with many engineers; and their writings had been sufficiently original and striking to attract much attention. The experience had, in fact, prepared them for their next venture, one which was destined to sever permanently the connection between the two men, and to open out for each new paths in widely diverging directions. The hard times of 1857 had absorbed what little money they possessed, but they could claim to be the owners of a more important capital—the confidence of many men of influence and means. It was notorious that at that time the construction and management of American railroads were in a deplorably backward condition compared with those of Europe, and the brilliant idea occurred to HOLLEY and COLBURN to get themselves made delegates of some of the principal railway companies in the United States; to travel over Europe and to collect information on the railway practice of the Old World which should be made useful for the improvement and perfection of railroads at home. To secure the patronage and assistance of many influential persons was a work of no great difficulty, and in the summer of 1857 they commenced their first voyage across the Atlantic, a voyage which was destined to bear immediate fruit, and to lay the foundation for their brilliant and, alas! too brief careers.

How great their energy was the result of the few weeks visit to Europe on that occasion still bears testimony, in the large volume they completed on the "Permanent Way and Coal Burning Boilers of European Railways." They were of an age when they could afford to burn the candle at both ends; and they did, under forced draught. In a memorandum by ZERAH COLBURN, now in my possession, I find the following reference to this book: "In 1857-58 I wrote the large work, entitled the 'Permanent Way and Coal Burning Boilers of European Railways,' Mr. HOLLEY'S name appearing as joint author, in consideration of our sharing the cost of the undertaking but more especially because of the assistance rendered by him in collecting information and preparing drawings." Those who can read between the lines of this memorandum, will understand how large HOLLEY'S part was in the preparation of this book.

At that time Mr. DANIEL KINNEAR CLARK had attained a considerable reputation both in England and in America, by his very excellent book on "Railway Machinery," and it followed almost as a matter of course that he was the first person in London sought out by HOLLEY and COLBURN when they arrived in 1857. At that time I was a boy in Mr. CLARK'S office; I, like HOLLEY, but in a very humble way, had been seeking despairingly for work, and a kind fate had placed me with Mr. CLARK in the summer of 1857. I never can recall without the deepest thankfulness the mysterious working of Providence which, apparently by the merest accident, brought me in contact with those two men.

It happened that they, coming direct to London, had gone straight to the office of Mr. CLARK, where I was alone, and thus I was the first person to shake hands with HOLLEY on his arrival. Twenty-five years later I was the last Englishman to shake him by the hand in London, when we said our final farewell. You cannot imagine the effect which the sudden apparition of the two young Americans, in the gloomy London office had upon me. They appeared to me like beings from a superior world, so unlike were they to any persons I had ever met before. Even with my untutored and crude power of perception, I could feel that they were surrounded by an atmosphere of energy and intelligence; that they were overflowing with vitality. The one seemed to me a spirit of darkness the other a spirit of light, and both so immeasurably my superiors that I could do little more than gaze on them in wonder. Who could at that time have supposed that the influence of these two men was to be made, under Providence, to change and fashion my whole career? that they were to show me the path to a future infinitely brighter and higher than I could then have planned in my most sanguine dreams? Yet so it was to be. Why they should even then have felt an interest in one so ignorant as myself has always been a source of wonder to me. I suppose there must have been some mysterious and inexplicable bond of sympathy. I know that they exercised a strange influence over me; that without my knowing it they widened and strengthened my mind; that I absorbed much knowledge from them. When their brief visit came to an end, and they returned to New York, most of the light went out of my life, though their influence remained behind, especially that of HOLLEY, whose bright individuality rested with me as an ideal, which I might perchance, with time and constant effort, feebly imitate. The following year ZERAH COLBURN returned to London alone; he became the editor of *The Engineer*, and I, having sought him out, had the privilege of being closely and intimately associated with him until the curtain fell upon his tragic end. As no doubt you know, after he returned to England in 1858, he made his permanent home there, with the exception of a few months in 1860, which he passed in Philadelphia. You are also aware that it was he who founded the London *Engineering* in 1866. Into the management of this journal he threw, for the first three years, the whole force of his great erratic powers. After their first visit to London, and their joint publication of the volume on European railways, HOLLEY and COLBURN, without becoming actually estranged, had but little in common. The dark and fiery genius of the one was in fact so opposed to the refined talents and noble soul of the other, that it was impossible for any real and lasting sympathy to exist between them.

With HOLLEY's return to America in 1858, or shortly afterwards, commenced the journalistic epoch of his career. For some years he was a valuable and industrious contributor to the New York *Times*, and certainly never before or since has any daily newspaper been so fortunate in the services of an engineering contributor. In 1859, and again in 1860, he visited England, chiefly to write upon a subject which was then attracting the attention of the civilized world—the *Great Eastern*. This business brought him into intimate contact with the engineers of that vessel, BRUNEL and SCOTT RUSSELL; with the last-named the acquaintance ripened into a warm personal friendship which always remained. The *New York Times; Railway Review;* inventions connected with the steam engine and permanent way; and miscellaneous literary employment, kept HOLLEY closely occupied, and brought him plenty of reputation, though but little money, until the War of Secession. It is needless to say that HOLLEY, like a good patriot, offered his able services to the Government, and it is interesting to add that his offers were uniformly declined. It was during this great national crisis that HOLLEY, while still holding on to his main support—a brilliant and facile pen—had the opportunity of taking up work more congenial to him. He was employed by Mr. STEVENS in 1862 to visit Europe in order to obtain information that might be useful in the construction of the Stevens battery, on which so much time and money, as well as skill, were wasted. Mr. SCOTT RUSSELL, who at that time had considerable interest in naval and military circles, rendered HOLLEY good service in obtaining for him introductions and information, while his own presence of mind and coolness often stood him in good stead in obtaining access to places the official doors of which were closed against him. It was this new connection that turned his mind to the production of that important hand-book on "Ordnance and Armor," which, when completed, was destined to remain for so many years the standard book of reference on the subject. Like every piece of work to which HOLLEY set his hand, this treatise bears on every page evidence of his capacity for taking infinite pains. The objection has been made by friendly critics in this country, that "Ordnance and Armor" was scarcely worthy of its author. I do not agree with this criticism, and in this I am sustained by one of the ablest practical designers of artillery in the world, M. G. CANET, who has written to me on this subject as follows:

> You have told me that recently you have had frequent occasion to study the "Ordnance and Armor" of A. L. HOLLEY. You could not refer to a better authority, for it is at once the most complete and the most conscientious work on the history of artillery that has ever been published. The name of HOLLEY recalls to me many souvenirs of the commencement of my career, and I want to tell you that for me no book on the same subject has ever been of so much value. HOLLEY wrote it at a time before artillery had become a science, properly so called; when even the phenomena attending the combustion of gunpowder were very imperfectly understood. At that time the strains to which gun carriages were subjected were not accurately known; and correct gun design was impossible, because the pressures exerted upon the bore of a cannon could not be measured. When HOLLEY's book appeared there existed only a few theoretical essays; the records of some doubtful experiments; the ill-sustained claims of a few manufacturers; and these were all scattered through different memoirs and reports. HOLLEY was the first to make a systematic summary of all these documents; to pass in able review, material, modes of construction, ballistical data, firing experiments, and penetration of plates. This last-named portion of his work had an especial value for, when he wrote, the art of constructing ironclad ships was in its infancy. What I find most remarkable in this work of HOLLEY is, that writing at the period from which modern artillery may be said to date, he made all the data he could obtain the object of minute and careful study, that every line bears the stamp of his own work, that it is an earnest study, and in no sense a piece of bookmaking. Every page contains abundance of detail, accuracy in facts, and a sureness of judgment which is truly admirable. His considerations on the resistance and elasticity of material, and on the effects of strains and vibrations, show the large grasp of a truly scientific mind. His investigations on the subject of reinforcing rings had at the time a high value, and to-day are of considerable interest. He showed conclusively that he understood the absolute importance of gaining information at every step by experiment, and that theory is but of comparatively little value in gun manufacture. It is difficult to realize all the changes that have taken place since his time in the construction of ordnance. Steel of high quality scarcely existed, and an entire revolution has taken place in design and in construction. We who have followed carefully all the transformations that have occurred in the art during 20 years, and who were familiar with it when HOLLEY wrote, gladly do homage to the man who could produce such a book from such materials. For my own part I owe him a debt of gratitude, for it was from his pages that I studied most often, and whence I drew my first clear notions of artillery. I reverence him not only as a savant but as a master.

I thought it would give you pleasure to hear the independent testimony of an eminent Frenchman who never knew HOLLEY, except through his writings on this special subject. When this book was published the art of heavy gun construction was far more tentative and experimental than it is now, and the classified collection of all information available up to the date of its publication served as a great aid in advancing a science then in its infancy. The strictly literary period of HOLLEY's career was now drawing to a close, and though he could never as long as he lived abandon his innate love for writing, he was no longer compelled to rely on his pen as a means to live. In May, 1863, he finally decided upon turning his talent and energies into another channel, one that was destined to lead him to fame and moderate prosperity.

(To be Continued.)

Rapid Electric Railway Construction.

An electrical railway was recently completed in Elmira, N. Y., with unusual rapidity when all the difficulties attending its construction are taken into account. On July 30, the Elmira & Horseheads Ry. Co., placed a contract with the Edison General Electric Co., for the equipment of 7,000 ft. of track, 6 motor cars, and a full station equipment. At the same time, a contract was placed with the John Stephenson Car Co., for 6 new cars. The contracts were made in both cases with a strong guarantee to the effect that the roads should go into operation September 1, in order to accommodate the Interstate Fair which was to open on that day. Both the Edison and Stephenson companies put their best men upon the work, and forwarded supplies with the utmost possible dispatch. On or about Aug. 15, the Stephenson Co., informed the Sprague Co., that its cars were ready for equipment, and at about the same time, the motors were shipped from the great Schenectady Works of the Edison Co., which have a capacity of from 15 to 20 street car motors per day. The strike on the New York Central at this time, bid fair to cause very serious delays as the cars were to be equipped in New York.

A special consultation of the Edison and Stephenson companies was held at Schenectady, and it was decided to ship the motors via the Delaware & Hudson and the Delaware, Lackawana & Western lines, a roundabout route, which necessitated special cars and unusual expedition. On Aug. 20, the completed cars began to go out from the Stephenson factory, 2 being shipped each day. In the meantime, a contract had been placed with the Simplex Co., of Boston, for the feed wire; the Edison Co. had forwarded all line material and supplies, and everything was on the ground but the poles, which were held in northern New York awaiting the arrival of cars which had been delayed on account of the New York Central strike. Poles were gathered about Elmira, and at 12 P. M., Aug. 23, the street construction work commenced. Provision for the dynamos and appliances had been made by engaging a part of the Westinghouse station at Elmira. On Aug. 31, notice was sent to the Railway Co. that the road would commence operation on the following morning, and promptly at 6 A. M., Sept. 1, the road carried its first passengers. For the next few days the tests of the machinery were excessive, the cars frequently having to carry 2 loaded trailers, and to remain in service from early morning until late at night.

They did their work satisfactorily, and the track gave no unpleasant evidence of the extreme haste in which it was laid.

Legal Decisions of Interest to Engineers.

Care Required of an Employer.—Neither individuals nor corporations are bound, as employers, to insure the absolute safety of the machinery or mechanical appliances which they provide for the use of their employés, but they are responsible for any injury which may happen through a defect of the machinery which was or ought to have been known to them and was unknown to the employé. (Washington & G. Ry. Co. v. McDade. Supreme Court of the United States, 10 Sup. Ct. Rep., 1,044.)

Duty of City in Repairing Sidewalk.—The superintendent of streets of a city discovered a plank loose and ordered his men to repair it, which they attempted to do, but so far failed that several people during the 3 days following noticed its defective condition. The street commissioner passed over the walk every day. The third day after the alleged repairs a lady was severely injured by stepping on the loose plank. The city is liable, as a futile effort to remedy a defect so simple as a loose plank is, under the circumstances, carelessness. (Moon v. City of Ionia, Supreme Court of Michigan, 46 N. W. Rep., 25.)

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Lehigh Valley.—Construction has been commenced on the Geneva & Van Ettenville R. R., projected from Geneva to Van Ettenville, N. Y., a distance of 57 miles.

Columbus, Shawnee & Hocking.—Work on the extension from Saltillo to Sayres, O., 11 miles, is nearly completed. The completion of the work has been greatly delayed by failure to secure timber for trestles. In the four miles of road between Reed's and Saltillo there is about 1 mile of trestle work, some of which is between 50 ft. and 60 ft. high. The rails are now on the ground and track will be laid as soon as the trestlework is completed.

Cleveland, Cincinnati, Chicago & St. Louis.—The route of the Brookville, Richmond & Union City R. R. has been surveyed from Brookville to Richmond and a very satisfactory route is stated to have been secured.

Baltimore & Ohio.—At a meeting of the stockholders recently held the lease of the Akron & Chicago Junction R. R. was ratified. The road which is to be completed by Jan. 1, 1891, extends from Akron to Chicago Junction, 73 miles, and will give the Baltimore & Ohio a route from Pittsburg. A branch road from Wooster, O., will tap the main line at Lodi. The latter was nearly all graded several years ago, and was recently purchased by Ryan & McDonald, who will complete it and turn is over to the Baltimore & Ohio.

Maine Central.—Wm. A. Allen, of Portland, Me., Chief Engineer, writes as follows:

> About 60% of the grading has been finished, and two miles of track have been laid on the extension of the Coos Valley Ry., from North Stratford, Vt., to Quebec Junction, N. H., 32½ miles. The maximum grade is 1¼5, and the maximum curve is 6°. There will be two bridges over the Connecticut River and over Israel River. The contractors are McDermid, Sinclair & Doheny, and they have about 1,000 men now at work on the line. D. W. Williams is the engineer in charge of construction.

Cincinnati, Saginaw & Mackinaw.—A correspondent writes us that the extension from Bay City, Mich., to Oa-at-ka Beach, 5 miles, was completed and opened for traffic July 1, 1890. The object of the road is to furnish the people of Bay City and vicinity railway connection with the beach, and it will do only a passenger traffic.

Alba, East Jordan & Short Cut.—David Ward, of Pontiac, Mich., writes as follows:

> This road is projected to run from a point on the Michigan Central R. R., northwest, a distance of 70 miles through a tract of pine timber land, to a point on the shore of Lake Michigan. The timber land is owned by myself, and the road is being built to develop it. A force of 60 men and 12 teams are now at work on the line, and about 40 miles of the grading have been completed.

Philadelphia & Reading.—A press dispatch says:

> The Philadelphia, Harrisburg & Pittsburg R. R. Co., which is controlled by the Philadelphia & Reading, will hold a stockholders' meeting on Oct. 14 to decide the question of issuing $2,000,000 of 5% bonds. This company is a sort of alliance between the Harrisburg and Potomac and Harrisburg Terminal Co., which were operated by the Reading. The Reading will guarantee the bonds. Construction work is now going on, and by next spring it is estimated that trains will be running to the Reading's connection. A spur will then be built to connect the Baltimore & Ohio. The money raised from the sale of the new bonds will be used to carry on the work.

Brigantine Beach.—Mr. Stout, the only representative of the old firm of Hill & Stout, of 42 Broadway, New York city, was Chief Engineer of this road, instead of the firm of Hill & Stout, as stated in our last issue.

Delaware & Hudson Canal Co.—At a meeting of the directors of this company, held last week, it was decided to make extensive improvements to the road and the service. It was voted to double track the road between Albany and Whitehall, although practically the double track now extends as far north as Gansevoort. Work will be begun at once, and it is expected that the two tracks will be completed as far north as Fort Edward by Jan. 1, while the entire work will be done by June 1. On the Champlain division long additional side tracks will be built to better provide for the movement of trains. The rolling stock will also be largely added to. Contracts have been awarded for 25 large locomotives and 1,000 coal cars. Many additional freight and baggage cars and passenger coaches will also be built. Four large 10-wheel passenger engines are now being built for this service.

Projects and Surveys.

York & Black Mt.—Chartered in Pennsylvania to build a railway from York, Pa., to the top of Webb's Hill.

Watertown & Camden.—A press dispatch says:

> Austin Corbin is here to-day in conference with local capitalists concerning the proposed railroad from Watertown to Camden, to connect with the Elmira, Cortland & Northern R. R. A committee of citizens was appointed to prepare a plan for the formal organization of a company. The road will be 60 miles long and will cost about $1,000,000. Mr. Corbin promises to be a large stockholder.

SOUTHERN.—Existing Roads.

Wilmington, Onslow & East Carolina.—F. L. Pitman, of Wilmington, N. C., Chief Engineer, writes as follows:

> Surveys will begin at once for the railway being built by the East Carolina Land & Railway Co. from Jacksonville to New Berne, N. C., a distance of 38 miles. The route is through a low, level country covered with pine woods affording easy work; maximum grade 1%, and maximum curve 2°. The principal business of the road will be in general agricultural produce and lumber. It is expected that tracklaying will commence in February, 1891.

Florida.—D. D. Rogers, of Ocala, Fla., Civil Engineer, sends us the following information:

> The line of the Atlantic, Gulf & Havana R. R. was located early in 1889 from St Augustine to Daytonia, Fla., and preliminary surveys were made to New Smyrna and De Land. The contract for the first 10 miles was let to S. J. Fox, of St. Augustine, Fla., and the grading had been completed when work was stopped by the yellow fever outbreak. Since that time work has been practically at a standstill, only a few men being employed in grading. At the present time about 15 miles of the grading have been completed and 20 miles of the right of way cleared.—The litigation between the Gainesville & Tallahassee R. R. and Gruell estate has been settled by the purchase of the latter's interests. This will consolidate the interests of the

railway company with those of the Tampa, Tallahassee & Western R. R. Co., surveys for which have already been made from Gainesville to Tallahassee, Fla. It is expected to begin construction soon. —The Savannah, Florida & Western R. R. Co. has completed the location of its line from Gainesville to Pemberton Ferry, and construction will commence soon. Both this line and the Tampa, Tallahassee & Western pass through the richest portion of the Florida phosphate fields. These deposits are of a much higher quality than was at first thought, there being only a small percentage of deleterious matter.

Paducah, Tennessee & Alabama.—N. R. Alcott, Chief Engineer writes as follows:

Fifty miles of this road from Paducah, Ky., south to the Tennessee State line has been completed and was opened for trafic Sept. 28. About 200 teams are now at work on the section from the State line to Paris, Tenn., which is to be completed by Dec. 1. T. P. Read is engineer in charge of construction.

Georgia Southern & Florida.—Wm. H. Wells, of Macon, Ga., Chief Engineer, writes as follows:

About 95 miles of the Macon & Birmingham R. R. have been graded and 64 miles of track laid. The road is projected to run from Macon, Ga., to Birmingham, Ala., a distance of 230 miles, of which 110 miles are in Georgia and 120 miles are in Alabama. The work is generally heavy; maximum grade 1% and maximum curve 5°. There will be iron bridges across the Flint, Chattahoochee, Tallapoosa, Coosa and Cahaba Rivers. Nearly all of the right of way has been obtained. The contractors are J. S. McTighe & Co., of Memphis, Tenn., who now have a force of 250 men tracklaying. The principal business of the road will be in iron, coal, timber and general merchandise.

Abbeville & Way Cross.—F. C. Hand, of Abbeville, Ga., Chief Engineer, writes as follows:

The location has been completed and construction is now in progress on the extension from Swan, Ga., to Ocilla, Ga. From Ocilla the road will ultimately be extended to Willacoochie, Ga., making the total length of the extension 30 miles. The work is generally light; maximum grade 66 ft. per mile, and maximum curve 6 degrees. The work is being done by a number of contractors who now have about 100 men at work on the line. The principal business of the road will be in naval stores, rosin, turpentine, lumber and agricultural produce.

Macon & Atlantic.—W. H. Wells, of Macon, Ga., Chief Engineer, writes as follows:

This road is intended to furnish a southern outlet for the Macon & Brmingham R. R., and is projected to run from Macon, Ga., Jefferson and Guyton, to some point on the Atlantic Ocean not yet made known, a distance of about 180 miles. The surveys have been completed to within 20 miles of the coast, and all of the right of way has been secured. The work is about average; maximum grade 1%, and maximum curve 4°. About 30% of the grading has been completed. The contractors are J. S. McTighe & Co., of Memphis, Tenn. J. S. Pattin, of Guyton, Ga., is engineer in charge of construction.

Florida Central & Peninsular.—The surveys are nearly completed for the extension of this road from Quincy, Fla., to a connection with railways centering at Birmingham, Ala.

Louisville & Nashville.—The extension from Sylacunga to Calera, Ala., has been completed and opened for traffic.

Alabama Midland.—The contract for building the Montgomery, Tuskaloosa & Memphis R. R. bridge over the Alabama River has been let to the Phœnix Bridge Co. The road has been graded and the work of laying the track will be commenced in a few days. As soon as the track is laid the bridge material will be delivered and the work of construction will commence. The grading of the road is nearly completed the entire distance between Montgomery and Tuskaloosa.

East Tennessee, Virginia & Georgia.—This company will, it is stated, commence work on the extension of the Rome & Decatur R. R. to Decatur, Ala., at once.

Roanoke & Southern.—A. Onderdonk, Chief Engineer, is quoted as saying: "The greater part of the line has been located and we have found it a comparatively easy and cheap route. We have improved on our calculations both in distance and in grading, and the cost of construction will be much less than was expected. The steepest grade will be in reaching the summit of the Blue Ridge. There will be several trestles but none of any great length. The longest will be across Pig River, Maggoty and Black Water Creeks. A few miles of the line in Franklin have not yet been located, and it is not determined whether or not the road will run through Rocky Mount. The dummy line at present runs four miles from that place. One line has been surveyed into Roanoke, coming directly into the city from the South, and crossing the river near the new bridge on South Jefferson St. Another line is now being run, branching off a few miles south of the city and striking the valley of the river opposite the West End, then running down the river to the Jefferson St. crossing. I am not prepared to say yet which is the most practicable route. On the original line some heavy grading will be necessary, and the other one will increase the distance, so that there will really be but little difference in the routes. I think it probable that the original line will be adopted, but the other has been suggested, and the survey is being made to demonstrate which is the easier. As soon as the line into Roanoke is definitely located the surveying party will locate the remainder of the line to near Rocky Mount. The work has not been put under contract, but will be soon after the route of entrance into the city is settled. The work on the road is being pushed forward as rapidly as possible. Thirty miles, or one-half the distance from Martinsville to Roanoke, are now under contract.

Charleston, Cincinnati & Chicago.—An official of this company is reported as saying that all the rails were on hand and that tracklaying would be completed from Rutherfordton to Marion, N. C., by Oct. 15. On the section from Marion to the Tennessee State line grading is being actively pushed. Grading on the extension to Augusta, Ga., is progressing favorably.

Bristol, Elizabethtown & North Carolina.—Work is making good progress on the line from Bristol to Mountain City. The work on the bridge at Elizabethtown, crossing the Watauga River, is nearing completion, and it is expected that trains will be running to this point by Jan. 1.

Projects and Surveys.

Charlottesville & Southern.—A correspondent writes: This road is projected to run from Charlottesville, Va., to a connection with the Richmond & Allegheny R. R., or to the James River, a distance of about 24 miles. The route is generally favorable and passes through a good agricultural and mineral region. There will be only one bridge of any size. The principal business of the road will be in soapstone, granite, iron, and agricultural produce. It is expected that surveys will commence in a few weeks, and that the contracts for construction will be let about January.

NORTHWEST.—Existing Roads.

Eastern Minnesota.—This company is building a short extension in West Superior, Wis.

Duluth, Pierre & Black Hills.—Surveyors are now locating this line from Aberdeen toward Pierre, S. Dak., and expect to have a portion of the road ready for the graders in a few days. Construction is already in progress at Pierre.

Port Arthur, Duluth & Western.—Large quantities of steel rails are arriving at Port Arthur for this road and tracklaying will be pushed. It is expected to have the road completed to Sand Lake by Jan. 1, 1891.

Chicago, Iowa & Pacific.—This company has been chartered in Iowa for the purpose of acquiring the Fort Madison and Northwestern R. R.

Projects and Surveys.

Emmetsburg & Des Moines.—Chartered in Iowa to build a railway from Emmetsburg to Des Moines, Ia.

SOUTHWEST.—Existing Roads.

Chicago, St. Paul & Kansas City.—An official of this road is reported as saying that the grading has been completed on the Leavenworth & St. Joseph R. R., and that tracklying will begin in a few days.

Kansas City Suburban Belt.—A correspondent writes us as follows:

The object of this road is to do a general suburban freight and passenger traffic and to furnish terminal facilities for the various railways entering the city. Six miles of double track road are already in operation and construction is now in progress on an additional 6 miles of single track. It is expected to begin tracklaying about Nov. 15.

Projects and Surveys.

Abilene & San Angelo.—About $43,000 of the required $50,000 to secure the construction of this Texas road has been secured.

ROCKY MT. AND PACIFIC.—Existing Roads.

Northern Pacific.—The Green River & Northern R.R. Co. has filed articles of incorporation with George Browne, J. H. Mitchell, Jr., and W. O. Chapman, incorporators. The object of the company is to build a railroad from Durham, Wash., in a general northerly direction, to a connection with the Seattle, Lake Shore & Eastern Ry. in the vicinity of Snoqualmie Falls, together with all branches or spurs connecting the railway with any other points in the State, as the trustees may determine. It is also the purpose of the company to build a railway from Palmer, on the line of the Northern Pacific R. R., in King County, running in a general westerly direction, by way of Muckleshoot prairie, to Stuck Junction.—The Lewiston extension of the Northern Pacific cannot be finished before next spring. Delay has been caused in trying to obtain a right of way across the Nez Perces reservation. The Interior Department is now negotiating with the Indians, and a conclusion is expected soon. Track is laid almost to Moscow, and will be extended as far as Kendrick in time to transport this year's crop.

Great Falls & Canada.—This road has been opened for traffic. The Great Falls & Canada R. R. Co. was organized last October, with Donald Grant, of Faribault, Minn., President, for the purpose of connecting with the railway of the Alberta Railway & Coal Co., whose headquarters are at Lethbridge, Alberta. Construction was commenced last spring and is now completed. The road will make another outlet for the coal mines at Lethbridge, the product of which is, it is claimed, is of a superior quality and the best in that section of the country. The Great Falls & Canada also completes a connection between the Canadian Pacific and the Great Northern, the former at Dunmore, Can., and the latter at Great Falls, Mont. Lethbridge is a place of about 1,500 inhabitants and gives great promise for the future. It is 198 miles from Great Falls and 110 from Dunmore. The new road runs through a fine grazing country.

Coos Bay, Roseburg & Eastern.—A large amount of material is arriving for the construction of this road and work is expected to begin in a few days.

Ilwaco Railway & Navigation Co.—Richard Habersham, Chief Engineer, has begun surveys for a line from Stout's, on the beach, to deep water on the Columbia River.

Atchison, Topeka & Santa Fe.—Grading has been commenced on the belt line at San Bernardino, Cal.

Fairhaven & Southern.—A force of 200 men are at work clearing the grade near the International boundary and it is expected that connection will be made with the Canadian Pacific branch in about a month. Work is in progress on the bridge across the Nooksack River and six of the ten spans of the Frazer River bridge are completed.

Denver & Rio Grande.—It is probable that this company will build a line from Wagon Wheel Gap up the valley of the Del Norte to Willow Creek, with a branch from Willow Creek to mines.

Montana.—A press dispatch says: The railways now in course of construction in the state of Montana are the Missoula & Cœur d'Alene cut off, the western extension of the Great Northern, the Great Falls & Alberta, a portion of the Cooke City & Rocky Fork branch of the Northern Pacific, and a number of smaller branches of the three trunk lines in the state. About 4,000 men are now employed on the Missoula cut-off. The road is being constructed by the Northern Pacific, and it is expected to have it completed to the state line by Nov. 1. About 25 miles of the extension of the Great Northern Ry. have been completed west of Fort Assiniboine, and the contractors are increasing their force of men so as to complete the 108 miles to the summit of the mountains before being compelled to quit work for the winter. On the Great Falls & Alberta only a few miles of track remains to be laid to complete the line from Great Falls to Lethbridge, Alberta. This road is being built by the Alberta Coal Co. to secure a market, and competition in freight rates now being in the hands of the Canadian Pacific. The line will open up coal fields among the richest in the northwest. The Northern Pacific is pushing the work on the branch to Cooke City, and if Congress grants the desired right of way through a portion of the park, the mines will be reached before hard winter sets in that mountainous region.

Projects and Surveys.

Boise Central.—This company wishes to secure money to build a railway from Boise City, Idaho, to a connection with the Oregon Pacific R. R., a distance of 47 miles. Secretary, Chas. A. Clark. Boise City, Idaho.

Montana & Wyoming.—Chartered in Montana to build a railway from some point in the southwestern part of the State to Helena.

CITY TRANSIT.

Dummy Railway.—***Joplin, Mo.***—Surveys are being made for a dummy line to Carthage, Webb City, Carterville and other important mining camps. Construction will begin as soon as the surveys are completed.

Cable Railway.—***Washington, D. C.***—The Washington & Georgetown R. R. has voted to operate a part of its system by cable. President Hurt is reported as estimating the cost of the change at $2,000,000.

Electric Railways.—New lines or extensions of existing plants are proposed at Boston, Mass., by the West End Street Ry.; Syracuse, N. Y., by the Syracuse, Eastwood Heights & Dewitt R. R.; Allegheny, Pa., by the Troy Hill Passenger Ry. and the Perry Street Ry.; Athens, Ga., address J. T. Voss; Clarksville, Tenn., address T. Carkuff; East Chicago, Ind., address J. G. Torrence; Houston, Tex., address Maj. W. H. Crank; Durango, Colo., address Joseph Prewitt; Corvallis, Wash.

Lawrence, Mass.—The Merrimac Valley Horse R. R. has received permission to use electricity on all its lines.

Jamestown, N. Y.—The Mayor and 6 Aldermen have been appointed a committee to investigate the proposed introduction of electricity on the street railway.

Troy, N. Y.—Baerman & Kaley have recently surveyed several new lines for the Troy & Albia Horse Ry.

Philadelphia, Pa.—The Traction Co., which has heretofore shown a decided preference for cable railways, is reported as about to build an electric line to Frankford, Tacony and Holmesburg.

Washington, D. C.—Engineers are reported to be locating an electric line from this city through Chevy Chase to Knowles or Kensington, Md.

Cumberland, Md.—A profile of the proposed electric railway has been prepared and will be laid before the City Council shortly.

Roanoke, Va.—E. T. Lynch, Jr., of New York City, will be in charge of the construction of the electric line here. The overhead trolley system will be used.

Lynchburg, Va.—The West Lynchburg Land Co. has made arrangements with C. H. Harman, President National Improvement Co., New York City, for a complete electric railway plant.

Atlanta, Ga.—The Atlanta, West End & McPherson Street Ry. has decided to adopt the Edison-Sprague system on its 5 miles of track. Both T and girder rails will be used.

Topeka, Kan.—The Topeka Rapid Transit Ry. has been granted permission to build an electric line.

Houston, Tex.—On Sept. 22 two new companies applied to the City Council for right to build electric lines.

Los Angeles, Cal.—A storage battery belt line is projected. Capt. Barrett can give information.

Madison, Wis.—According to newspaper reports some eight or ten miles of new street railway track will be laid and the whole system operated by electricity.

New Companies.—Woronoco Street Ry., Westfield, Mass.; Sec'y., S. B. Campbell. Verner Street Ry., Allegheny, Pa.; capital stock, $6,000; directors, G. W. Henderson, J. N. Hill and others. Knoxville, Va., Street Ry., capital stock, $100,000. Underground Electric Traction Co., Baltimore, Md.; capital stock, $100,000; incorporators, J. J. Husband, F. L. Morling, J. J. Meyer and others Ocmulgee Street Ry., Macon, Ga.; capital stock, $100,000; incorporators, J. C. McBurney, J. W. Cabaniss, J. S. Baxter and others. Electric Belt Line Ry., St. Augustine, Fla., capital stock, $75,000; incorporators, H. Canfield, C. D. Blauvelt, G. Old. Chicago, Ill., Electric Transit Co.; capital stock, $12,000,000; J. M. Hannahs, W

H. Powell, G. W. Stanford. Northwestern Electric Street Ry., Chicago, Ill.; capital stock, $200,000; incorporators, W. Boldenweck, P. J. Maginnis, G. Sill. Taylor Street Ry., Austin Tex.; capital stock, $20,000.

BRIDGES, TUNNELS AND CANALS.

Bridges.—*West Sparta, N. Y.*—An iron bridge will be built across the Canaseraga River to replace the one recently destroyed by floods.

Salem, Mass.—Bids will be received until Oct. 6 for the construction of an iron pivot drawbridge over the Powow River.

Dayton, Tenn.—Bids will be received for the construction of two iron bridges to Englewood.

Burlington, Ia.—There is talk of spanning the Mississippi at Burlington with a pontoon bridge. Stewart, the pontoon bridge builder, offers to build a first-class structure for $12,000 and to have it completed in 30 days.

Midlothian, Tex.—A bridge is proposed over Soap Creek.

Round Timber, Tex.—An iron bridge over Spring Creek, Baylor Co., is talked of.

WATER-WORKS.

NEW ENGLAND

Eastport, Me.—A new pumping station and dam are to be constructed by the Eastport Water Co., near Perry.

Antrim, N. H.—We have received the following from S. R. Robinson:

If the works are built the work will probably be done by a private party. At the annual meeting in March S. R. Robinson, T. D. Dresser and C. B. Gardiner were appointed a committee to investigate the question of supplying the village with water. Engineer George C. Patten, of East Deering, N. H., is preparing plans for bringing water from springs, 1¼ miles west of the village. The reservoir will be 181 ft. higher than Main St. Population, 500.

Milford, N. H.—J. M. Laws, Town Clerk, informs us that the town has voted to buy at once the plant of the Milford Water-Works Co.

Lowell, Mass.—The Board of Aldermen has again passed a resolution authorizing a loan of $6,000 for a new pumping engine of 10,000 galls. capacity.

Olneyville, R. I.—The question of laying some 20-in. pipe and setting several new hydrants is under consideration. W. N. Fiske is the Water Commissioner.

MIDDLE.

Huntington, L. I., N. Y.—Two companies are interested in the question of putting in a system of water supply; one a home and the other an outside company, the latter represented by George Olney.

Washington, D. C.—District Commissioner Lusk, in his annual report, recommends that an appropriation of $130,000 be made for laying new mains, setting new hydrants, etc., during the coming year.

SOUTHERN.

Berryville, Va.—The Berryville Water Co. will receive bids until Nov. 1 for the construction of works. A. J. Lee, Pittsburgh, Pa., is engineer. Secretary, T. S. Thompson, may be addressed for copies of the plans and specifications.

Roanoke, Va.—Extensions are being made.

Dublin, Ga.—The citizens are making an effort to have a well put down.

Gainesville, Ga.—Engineer N. W. Davis, of Atlanta, Ga., is now putting in works in accordance with plans and specifications prepared by him in July. Water is to be pumped from a large supply well through a 10 in. main to a reservior or stand-pipe, thence by gravity into the supply pipes. The well will be supplied from Castleberry Creek, a mountain stream, about 2¼ miles northwest of Gainesville.

Griffin, Ga.—Construction work is progressing rapidly. The supply is to be taken from springs. E. P. Hunter is superintendent of construction.

La Grange, Ga.—The following is from E. D. Putnam, Mayor:

The city will have an act passed by the Legislature in November providing for an election to vote on issuing bonds for water-works. If works are built, water will probably be pumped from springs or a creek to a stand-pipe. It is hoped that contracts may be let in December.

Macon, Ga.—It is reported that Eastern capitalists are investigating with a view of purchasing the entire plant of the Macon Gas Light and Water Co. for $175,000.—— Engineer E. F. Fuller, of New York, is looking over the company's plant with a view to making an estimate of its value.

Montezuma, Ga.—The town wants a system of water supply.

Riverside, Fla.—(A suburb of Jacksonville, Fla.)—The Riverside Artesian Well Co. has been granted permission to lay water mains through the streets. An artesian well is now being put down. Stephen E. Foster, Secretary, can furnish information.

Grenada, Miss.—A citizens' vote is to be taken on the question of issuing $20,000 of 20-year 7% bonds for building water-works, etc.

Water Valley, Miss.—A large majority vote has been cast in favor of issuing $10,000 of bonds for constructing water-works, etc. The question is in the hands of the Board of Aldermen.

West and North Knoxville, Tenn.—It is reported that a stock company is being organized to purchase land near Knoxville, Tenn., and lay a pipe-line to convey spring water to these towns.

South Pittsburgh, Tenn.—A new reservoir is to be constructed by the company.

Middlesborough, Ky.—The following is from A. H. Martine, Chief Engineer and Superintendent of the Middlesborough Water Co.:

The present temporary supply is pumped from Yellow Creek to a tank on Arthur Heights, the artesian well mentioned in the last *Manual of American Water-Works* having been abandoned. The company will build a dam about 35 ft. in height across Yellow Creek Valley. The will have a masonry heart-wall, founded on rock, and probably impound about 400,000,000 galls.

A 6,000,000-gall. vertical pumping engine will force water through a 24-in. main to a 1,000,000-gall. stand-pipe, 275 ft. above the city. The contract for the pump has not been let, but the stand-pipe will be built by the Cunningham Iron Works, of Boston. About 12½ miles of 24 to 4 in. pipe will be laid and 50 hydrants set. The 24 and 20 in. pipe will be furnished by the Anniston (Ala.) Pipe Works, and the remainder of the pipe and all specials by the South Pittsburg (Tenn.) Pipe Foundry. Ludlow valves and hydrants will be used. It is expected that the works will be completed by July or August, 1891.

NORTH CENTRAL

Eaton, O.—John W. Hill, Consulting Engineer, of Cincinnati, O., has been engaged to prepare plans and estimates for a system of works.

Marysville, O.—We have received notice that contracts have been awarded as follows:

Cast-iron pipe and specials, Ohio Pipe Co., Columbus, O., pipe, $26.93 per ton; specials, 2½ cts. per lb.; valves, Galvin Brass & Iron Works, Detroit, Mich.; hydrants, Holly Mfg. Co., Lockport, N. Y.; stop boxes, Bingham & Taylor, of Buffalo, N. Y.; pipe-laying and erecting pumping station, Wm. Patrick & Co.; driven wells, E. A. Stimson & Co..

The contract for pumping machinery, storage dam and influent pipe, is yet to be awarded. Estimated total cost of works, $50,000. John W. Hill, of Cincinnati, O., is the Consulting Engineer.

Van Wert, O.—We are informed that contracts for building works will be let next week.

Huntington, Ind.—Consulting Engineer John W. Hill, of Cincinnati, O., informs us that the following contracts have been awarded:

Cast-iron pipe and special castings, Addyston Pipe & Steel Co., Newport, Ky.; pipe, $26.40; specials, 2½ cts.; stop valves, Galvin Brass & Iron Works, Detroit, Mich.; hydrants, Bourbon Copper & Brass Works, Cincinnati, O.; valve boxes, A. W. Morgan; pumping machinery, Boughen Engineering Co.; driven wells, E. A. Stimson & Co.

Estimated total cost of works, $100,000. The plant is to be completed early in 1891. The water company will build the pumping station, lay the mains and the intake pipe and construct the intake pier.

Jeffersonville, Ind.—The suction pipe connection with the river is to be reconstructed, and an auxiliary infiltration well is to be built. Consulting Engineer John W. Hill, of Cincinnati, O., has been engaged to prepare plans and estimates.

Madison, Ind.—Estimates and plans for an infiltration well are to be prepared by Consulting Engineer, John W. Hill, of Cincinnati, O.

South Bend, Ind.—The flume supplying water to drive the water wheels at the pumping station recently collapsed, leaving the city dependent upon one steam pump. A new flume, estimated to cost $5,000, will be built.

Terre Haute, Ind.—Difficulties between the City Council and the Terre Haute Water-Works Co. seem likely to be settled in an equitable way, the company showing commendable fairness in its propositions, according to the Terre Haute *Express* for Sept. 28. The Council claimed that there had been inefficient pressure, impure water, an excessive number of hydrants and unfair rates for some purposes. The company claims that the pressure will soon be increased and the water filtered, and offers to adjust the other troubles.

Detroit, Mich.—Natural gas, it is reported, will be adopted as fuel for the pumping works.

Kalkaska, Mich.—We have received the following official information.

The Michigan Pipe Co., of Bay City, Mich., has been awarded contracts to furnish the town with about 3½ miles of 3, 4, 6 and 8-in. "Improved Wyckoff water pipe," as well as the special castings and valves necessary in the construction of their new water-works system, and 30 double nozzle hydrants. All the material is to be ready for operation this fall.

Monticello, Ill.—Bids will be received until Oct. 15 for sinking and casing a well not more than 500 ft. in depth, or less, at the option of the city. The well must be cased with wrought iron, 6 ins. in outside diameter, having screw and socket joints, and weighing not less than 9,346 lbs. per ft.

River Forest, Ill.—The River Forest Water, Gas and Electric Light Co. was incorporated Sept. 23 by H. E. Broughton, F. C. Smith and Henry Struble, with a capital stock of $75,000. The company proposes to construct water-works at once.

NORTHWESTERN.

Toledo, Ia.—The contract for constructing the water-works has been awarded to Geo. C. Morgan, of Chicago.

Argentine, Kan.—Plans have been drawn for a new pump-house to be located at the east end of the Santa Fé yards. It will contain three large boilers.

Lexington, Neb.—The City Council has ordered plans drawn for a $20,000 system of water-works.

Meriden, Neb.—A contract for an artesian well for the water-works has been let.

Schuyler, Neb.—A committee has been appointed to investigate the construction of works. Address E. L. True or C. J. Phelps.

Sturgis, S. Dak.—The town now has under consideration a proposition to establish a water supply system.

Fargo, N. Dak.—E. P. Wheeler, Beloit, Wis., and F. Wing, Kansas City, Mo., appraisers of the works of the Fargo Water & Steam Co., have submitted their report. Their valuation of the plant is $65,748. The city will pay $15,800 in cash, and assume the indebtedness of the company, $48,000, with accrued interest on the same, $1,120. The balance, $828, is practically due the city from the company.

Springfield, S. Dak.—A. T. Bridgeman has sent us the following:

Gray Bros. & Co., of Milwaukee, Wis., have been awarded the contract for sinking an 8-in. well. Work will be commenced on Oct. 15. The well is to furnish power at first for running a flouring mill. Later, a main will probably be laid for supplying water to the town. Engineer, S. Henderson. Chairman Water Board, R. Groat. J. L. Turner may be addressed for information.

SOUTHWESTERN

Kansas City, Mo.—An ordinance to pave and grade a a large number of streets has been reported from the engineering department.

Kansas City, Mo.—A nearly unanimous vote was cast at the special election on Sept. 23, favoring the amendment to the city charter to allow the city to build new works, buy or lease the existing works, or to renew the contract with the water company. Before any proposition is accepted as final the citizens will again vote upon it.

Flatonia, Tex.—Works are projected.

Floresville, Tex.—A recent fire has increased the desire for water-works.

Henrietta, Tex.—The Henrietta Improvement & Water Co. intends to build works here.

Toakum, Tex.—It is reported that a contract for works has been let.

Del Norte, Col.—An agreement has been reached between the town and the Mill Co. relative to water-works and the construction of the system will be begun at once. Bonds have been ordered issued. George D. Nichol will be engineer in charge, and S. P. Hoyne will superintend the excavations.

PACIFIC.

Blaine, Wash.—The supply main is now being laid to connect with some springs.

Gervais, Ore.—The city has let a contract for a windmill and tank costing $1,000, and about 450 ft. of pipe will be laid for fire protection.

Payson, Utah.—There is some talk of putting in works, but the matter is very indefinite.

Alessandro, Cal.—The contract has been let for laying a pipe line to the town. It will be about 20 miles long by 2 ft. in diameter, and carry 1,000 ins. of water. The new water supply system for the city is nearly completed.

CANADA.

Cote St. Antoine, P. Q.—The company has requested the city of Montreal to connect the latter's high level main with the company's mains.

St. Johns, P. Q.—An appraiser has valued the private works here at $48,000, and the town has offered the owners $55,000 for the plant. The offer, probably, will not be accepted, as the owners claim that the price must be determined by the revenue.

Pretanguishene, Ont.—Town Clerk Henry Jennings has sent us the following information:

Contracts will be let on Oct. 4 for works to be completed in Jan., 1891. Estimated cost, $18,000 to $20,000, to be procured by town debentures. Water will be pumped from springs to a tank to be constructed on a 50-ft. elevation. Chairman Water Board, C. Beck. Engineer for all work, John Gall, of Toronto, Ont. Population, 2,700.

Gananoque, Ont.—Sealed tenders will be received until Oct. 20 for doing all work and supplying all the material and machinery for a complete system of water-works, including the erection of a pump house, with required machinery and appliances, in accordance with the plans and specifications of Willis Chipman, C. E., of Toronto, Ont. Form of tender can be had on application to S. McCammon, Town Clerk.

Winnipeg, Man.—A motion has been made by Alderman Black to the effect that the Winnipeg Water-Works Co. be notified of the city's intention to purchase the company's works, and requesting the latter to appoint an arbitrator within 30 days. The resolution names Thos. C. Keefer, Ottawa, as arbitrator for the city.

ARTESIAN WELLS

Charleston, S. C.—A 1,200 ft. well is to be put down by the Eureka Ice Co.

Abbeville, Ga.—Arrangements are being made to bore a well.

Darien, Ga.—Another well is to be sunk.

Vienna Ga.—The authorities are preparing to sink a well in Courthouse square.

Tennille, Ga.—An artesian well is to be sunk. If it is a success a water supply system will be erected.

Arcadia, Fla.—It is reported that an artesian well is to be put down by Reed Bros.

Jacksonville, Fla.—A well is being driven at the electric light station. It will be 1,000 ft. deep and 10 ins. in diameter.

Huron, S. Dak.—The South Dakota Board of Irrigation will receive bids for putting down ten 6-in. wells in Beadle, Brown and Spink counties. The wells must furnish 100 lbs. pressure.——A second artesian well has been carried to a depth of 650 ft., where a flow has been obtained. The well will be sunk deeper.

Terrell, Tex.—Another artesian well will be sunk.

Golden, Col.—Tubular wells are to be sunk by the Irrigation & Hydraulic Co. to secure a water supply for the placer fields in this vicinity. The most improved boring machinery will be required for this work. About $50,000 will be expended. Address J. B. Mayo, Superintendent.

Moffat and Garrison, Col.—The Denver & Rio Grande R. R. Co. is sinking wells at these places to supply water to the San Luis district.

IRRIGATION.

Tarpon Springs, Fla.—The Tarpon Springs Irrigation and Development Co. has been incorporated to build works. Capital stock, $250,000. The incorporators are: A. P. K. Safford, G. B. Johnson, J. C. Fromme and others.

SEWERAGE AND MUNICIPAL.

Paving has been ordered in the following cities: Pittsburg, Pa., grading, paving and curbing; Americus, Ga.; Topeka, Kan., brick; Alameda, Cal., macadamizing. Grading has been ordered at Troy, N. Y., Providence, R. I., Newark, N. J., Omaha, Neb., Duluth, Minn., St. Paul, Minn.

Toronto, Ont.—A number of streets have been ordered paved with asphalt and cedar block.

Buffalo, N. Y.—Assessment rolls have been filed for asphalt paving on a number of streets.

Newark, N. J.—A number of streets have been ordered paved with oblong trap blocks and cobble stone.

Columbus, O.—Grading and paving with asphalt, stone or brick has been ordered on several streets.

Argentine, Kan.—Macadam and cedar block pavements have been ordered on a number of streets.

San Francisco, Cal.—Street Superintendent Ashworth has advised macadamizing, bituminous rock paving and grading on a large number of streets.

Sewers have been ordered at Chelsea, Mass.; Lincoln, R. I., Buffalo, N. Y., 10, 12 and 15-in. tile; Pittsburg, Pa., Duluth, Minn., St. Paul, Minn., Los Angeles, Cal., 8-in. pipe; Toronto, Ont.

Rochester, N. Y.—A large sewer, costing $37,000, has been ordered.

New York City.—Proposals for sewers costing over $600,000 are now advertised.

Washington, D. C.—Capt. Lusk has estimated the expenses for sewerage works during the coming year at $45,000 for cleaning and repairs, $25,000 for replacing obstructed sewers, $347,500 for new works, and $17,500 for incidentals, making a total of $547,390.

Hoboken, N. J.—Plans for a new system of sewerage and drainage, costing $250,000, have been prepared.

Newark, N. J.—The Council Committee on Sewers have reported orders for a number of new sewers.

McKeesport, Pa.—A 7-ft. brick sewer costing nearly $30,000 is proposed.

Cincinnati, O.—Ordinances for a number of sewers have been forwarded to the City Council by the Board of Public Improvents.

Columbus, O.—Pipe sewers, 20, 18, 15 and 12 ins. in diameter, have been ordered.

Springfield, Mo.—Surveys for a complete sewerage system are being made by Nier & Hartford, of Chattanooga, Tenn.

Red Oak, Ia.—The City Council has decided to put in a sewerage system as soon as possible.

Street Lighting.—*Toronto, Ont.*—The cost of the system as provided under the recent tenders would be, 930 electric lights at 29¾ cents per night, $100,986; 945 ordinary gas lamps at $23 each per annum, 55 Lambeth lamps at $73 each per year; a total of $126,736.

Washington, D. C.—Capt. Lusk, of the Engineer Corps, U. S. A., has reported in favor of an expenditure for $46,000 for electric light extensions, and suggests that the gas lamps be lit 3,000 hours per annum instead of 2,000 as now. This increase would entail an addition of $13,000 to the $138,000 now paid for gas lights.

Gas Plant.—*Nashville Tenn.*—City Engineer Jowett has prepared plans for a gas plant and mains to be built by the city. The work will require nearly 130 miles of pipe and the cost is estimated at $441,300.

Bonds.—*Louisville, Ky.*—The City Council has authorized the issue of $100,000 of paving and $20,000 of sewer bonds.

ELECTRICAL.

Electric Light plants are proposed at Hyattsville, Md., address J. H. Ralston; Hinton, W. Va.; Carrollton Ga., address D. F. New; Darien, Ga.; Lakeland, Fla., address H. C. Sloan; Lake Charles, La., address the M. T. Jones Co., Plaquemine, La.; Catlettsburg, Ky., address Carpenter Electric Light & Power Co.; Frankfort, Ky., address the Allen-Bradley Co.; Peach Orchard, Ky., address the Great Western Mining & Mfg. Co.; Fenton, Mich.; So. Denver, Colo., address the So. Denver Light & Power Co.; Modesto, Cal., address A. C. Swain, of Merced, Cal. Extensions are contemplated at Sumter, S. C., by the Sumter Electric Light Co. and at New Orleans, La., by the Louisiana Electric Light Co.

Washington, Pa.—The city has contracted with the Edison Co. for 46 street arc lights at $75 per light per annum.

Richmond, Va.—There is some prospect of the city gas works buying an electric light plant.

Independence, Kan.—The City Council has awarded contracts for street lighting to the Gas company at $1 per light per month and to the Electric Light Co. for 2,000 c. p. lights at $4 per month.

New Companies.—Derry, Pa., Electric Light Co.; capital stock, $5,000; incorporators, G. F. Huff, A. O. Caven and E. Pitcairn. Orangeburg, S. C., Electric Light & Power Co.; capital stock, $3,000; Charles Cope, Sec'y. Titusville, Fla., Electric Light Co.; capital stock, $10,000; Sec'y, S. F. Gray. Hazletine Electric Co., St. Louis, Mo.; capital stock, $650,000; incorporators, C. W. Hazeltine, G. W. Parker, D. R. Russell.

CONTRACTING.

Paving.—*Newark, N. J.*—Recent street contracts were made at the following prices: Filling, 40 cts. per cu. yd.; 20 × 4-in. curb, 40 cts. per ft.; bridging, 25 and 40 cts. per sq. ft.; square trap blocks, $1.69 per sq. yd; oblong granite blocks, $2.79 per sq. yd.

New York City.—Recent bids for street work were at the following figures: 14,200 sq. yds. trap block pavement, $2.13 and $2.43 per sq yd.; 5,840 sq. yds. of same, $2, $2.01 and $2.25 per sq. yd.; 13,500 cu. yds. excavation, 20, 29, 30, 40 and 60 cts. per cu. yd.; 17,600 cu. yds. rock excavation, $1, $1.20, $1.35, $1.40 and $1.50 per cu. yd.; 55,000 cu. yds. filling, 33, 35, 37 and 50 cts. per cu. yd.; 460 sq. ft. new flagging, 23 and 24 cts. per sq. yd.; 29,400 sq. ft. new flagging, 23, 26, 27 and 30 cts. per sq. yd.

Kansas City, Mo.—The last report of the Board of Public Works states that within the last three months, 10,832 sq. yds. of asphalt paving costing $30,328, and 27,756 sq. yds. of cedar block paving costing $40,476 have been laid.

Columbus, O.—A recent contract for asphalt paving was awarded at $2.57 per sq. yd.

Grading.—*Omaha, Neb.*—Recent bids for street grading were at 12.4, 13.25 and 14 3 cts. per cu. yd.

Sewers.—*Baltimore, Md.*—Prices on recent bids for sewer work ranged as follows: Broken stone, $1.59 to $2 per cu. yd.; sand, 68 to 73 cts. per cu. yd.; paving blocks, $108.75 and $160 per M.; hand-made brick, $8.25 and $8.50 per M.; Roundtop cement, $1.12 per bbl.; Rosendale, $1.25; Portland, $2.90 to $3: Crescent, $1.19; Cumberland, $1.55.

Los Angeles, Cal.—Contracts have recently been awarded for sewer pipe at the following rates: 24-in., $1.95 per ft. and $7.25 for Y branches; 20-in., $1.32½ per ft. and $5.09 for Y branches; 18-in., $1.13 and $1.14 per ft. and $4.35 and $4.38 for Y branches; 15-in., 85 cts. per ft. and $4.85 for Y branches.

Levee Work.—*Alexandria, La.*—Recent contracts were awarded at 19¾ and 19½ cts. per cu. yd.

PROPOSALS OPEN.

Sewers.—*Chicopee, Mass.*—Laying 1,000 ft. of 24-in. pipe, which is furnished by the town. E. Gaylord, Oct. 6.

New York City.—Several large contracts. T. F Gilroy, Oct. 15.

Cleveland, O.—C. G. Force, Oct. 9.

Columbus, O.—A number of 12 and 15-in. pipe sewers. Board of Public Works, Oct. 10.

Streets.—*Boston, Mass.*—Grading. Park Commission. Oct. 6.

Flatbush, N. Y.—Grading, paving, curbing and laying cross walks. Street Board, Oct. 8.

New York City.—Large amount of repaving. T. F. Gilroy, Oct. 7.

Marietta, Ga.—Macadam road to the national cemetery. Major J. W. Scully, Atlanta, Ga., Oct. 25.

Cleveland, O.—Grading, paving with asphalt on concrete foundation, resetting curb. C. G. Force, Oct. 9.

Columbus, O.—Asphalt, stone or brick paving on several streets. Board Public Works, Oct. 10.

St. Paul, Minn. Grading. R. L. Gorman, Oct. 9.

Training Wall.—*Savannah, Ga.*—Separate bids are wanted for the dredging and stone work. O. M. Carter, Oct. 15.

Sea Wall.—*Governor's Island.*—Col. D. C. Houston, 39 Whitehall St., New York City.

Pile Wharf.—*Sandy Hook, N. J.*—Lieut.-Col. G. L. Gillespie, Army Building, New York City, Oct. 25.

Drawbridge.—*Salem, Mass.*—Pivot drawbridge over Powow River, County Commissioners, Oct. 6.

MANUFACTURING AND TECHNICAL.

Cars.—The Pullman Co is reported to be building two unusually fine vestibule sleeping-cars for the Indianapolis-Chicago express on the Pennsylvania R. R. Barney, Smith & Co. are building a number of passenger coaches for the Toledo, Peoria & Western Ry.

Locomotives.—The Columbus, Hocking Valley & Toledo Ry. has contracted with the Baldwin Co for 10 heavy freight locomotives. The Louisville, New Albany & Chicago Ry. will buy five heavy passenger locomotives. The New York Central R. R. has recently completed 30 large freight locomotives. The Jacksonville, Tampa & Key West R. R. is reported to have recently ordered 25 new engines. The Western Ry. of Alabama recently received three new 82¾-ton 10-wheel locomotives.

The Strong Engine is now in use in hauling freight between Cincinnati and Dayton over the Cincinnati, Hamilton & Dayton road, and when hauling 75 loaded cars it moves along seemingly without trouble.

A Big Consolidation.—The Pierre, S. D., Street Ry., the gas, electric light and the water-works companies were recently consolidated, hereafter to operate under one head.

A Large Hotel.—Arrangements have been perfected for building a $2,000,000 hotel in San Antonio, Tex. This will be one of the largest hotels in the South.

A New Pier in Brooklyn, N. Y., 42 × 241 ft. will be built to facilitate the freight transfers of the Baltimore & Ohio R. R. The piers and floats will be used jointly by the Baltimore & Ohio, Reading, and New Jersey Central lines.

The Washburn & Moen Mfg. Co. recently built 9 miles of wire fence in Mahwah, N. J., a large part of which is 9 ft. high and built with 15 strands of galvanized steel wire and iron cross stays.

M. T. Davidson recently sent eight Davidson pumps to Havana, Cuba, eight to Rio Janeiro, Brazil, and 47 to San Francisco, Cal.

The Enterprise Iron Works, Youngstown, O., will erect a new building 175 by 80 feet which will contain 10 double puddling furnaces with a 20-in. three-high muck trains.

The Omaha Union Depot contract has been let to A. Johnson, of that city. The finished building will probably cost $900,000.

A New Electric Co.—P. H. ALEXANDER, C. H. BARNEY and CHAS. E. CHAPIN, recently officers of the Sawyer-Man Electric Co., New York City, have formed a partnership under the name of Alexander, Barney & Chapin for the purpose of manufacturing and dealing in general electric supplies.

The Bethlehem Iron Works proposes to increase its capital stock from $3,000,000 to $5,000,000, owing to the impetus given to the steel industries by the government contracts for armor and gun metal. Within 12 months, this company propose completing a plant for turning out as heavy armor as is constructed in any country.

New Corporations.—Indiana Contract Co., Evansville Ind.; capital stock, $20,000; directors, J. & J Nugent, J. Erchel, J. Arnold. Great Western Electric Supply Co., Chicago, Ill.; capital stock, $250,000; incorporators, H. W. Wolf, T. G. O'Donnel, A. A. Fliss. Madison, Ill., Car Co.; incorporators, L. M. Ramsey, C. F. Orthwein, W. Bacon. Madison, Ill., Water-works, capital stock, $20,000; incorporators, C D. McLure, C. C. Bainwater, M. Ramsey. Ironwood, Mich., Water Co.; capital stock, $100,000. River Forest, Ill., Water, Gas & Electric Light Co.; capital stock, $15,000; incorporators, H. E. Broughton, F. C. Smith, H. Stuible. Columbian Exhibition & Transit Co., Chicago, Ill.; capital stock, $100,000; incorporators, P. J. McMahon, E. V. Hitch H. C. Caulkins. Elliott Electric Co., Chicago, Ill.; capital, $100,000; incorporators, M. W. Elliott, F W. Parker, C. P. Chapman. Consolidated Electric Co., Chicago, Ill.; capital stock, $300,000; incorporators, H. Lampert, Jr., L. B. Langworthy, B. J. Dahurs. Western Bituminous Rock Co., East St. Louis, Ill.; capital stock, $1,200,000; incorporators, G. N. Truesdale, J. A Duffy, F. Watkins.

Metal Market Prices.—*Rails*—New York: $30 to $31; for old iron rails, $26. Chicago: $33.50 to $34; old rails, $26.75 to $27 for iron, $18.50 to $22 for steel. Pittsburg: $31 old rails, $28 to $28.25 for iron; $21.50 to $22 for steel.

Foundry Pig-iron.—Chicago: $15.50 to $17.50. Pittsburg: $15.50 to $17.50. New York: $16 to $18.

Track Materials.—New York: steel angle bars, $1.80 to $1.95; spikes, $2.20 to $2.25; track bolts, 2.95 to 3.10 cts. with square, and 3.10 to 3.15 cts. with hexagon nuts. Pittsburg: splice bars, 1.95 to 2.05 cts. for iron, 2 to 2.1 cts. for steel; spikes, 2.2 cts.; track bolts, 2.85 with square, and 3 cts. with hexagon nuts. Chicago: splice bars, 2.25 to 2.3 cts. for steel, and 2.15 to 2.2 cts. for iron; spikes, 2.2 to 2.25 cts; iron track bolts $3.15 with hexagon nuts.

Pipe.—Cast-iron, $27 to $30 per ton. Wrought iron, discounts as follows: 47½ and 40 per cent. on black and and galvanized butt-welded; 60 and 47½ on black and galvanized lap-welded. Casing, 50 per cent.

Lead.—Chicago, 5.2 cts.

Structural Material.—Pittsburg: angles, 2.25 cts.; tees, 2.8 to 2.85 cts.; beams and channels, 3.1 cts.; sheared steel bridge plates, 2.65 to 2.7 cts.; universal mill plates, 2.35 cts.; refined bars, 1.9 to 2 cts.; steel plates, 4.25 to 4.75 cts. for fire box; 3.1 to 3.2 cts. for flange; 2.9 cts. for shell, 2.5 to 2.55 cts. for tank. New York: beams, 3.10 cts.; plates, 2.25 cts.; angles, 2.1 to 2.25 cts.; tees, 2.6 to 2.7 cts.; channels, 3.1 cts. Chicago: angle, 2.35 to 2.4 cts.; tees, 2.9 to 3.0 cts. beams, 3.2 cts.; universal plates, 2.45 to 2.55 cts.

Constructing Sewers.

Sealed proposals will be received at the office of the City Auditor of the city of Dayton, until 12 o'clock noon, Monday, Oct. 13, 1890, for furnishing material and constructing about 12 miles of brick and pipe sewers, according to plans and specifications on file in the office of the City Civil Engineer.

Forms of proposals, copies of the specifications and instructions to contractors may be obtained at the office of the Board of City Commissioners or City Civil Engineer in Dayton, O., and at the office of Cady Staley, engineer of sewers, at Cleveland, O.

Plans and specifications may be seen at the office of the City Civil Engineer in Dayton, O., after Sept. 30, 1890.

The board reserves the right to reject any or all bids.

By direction of the Board of City Commissioners. G. C. WISE, President.

C. A. HERBIG, City Auditor. 39-2t

City of Toronto, Canada.

TENDERS FOR PUMPING ENGINES.

Notice is hereby given that the Committee on Water-Works of the municipal corporation of the City of Toronto will receive tenders, addressed to the undersigned, by registered post only, up to the hour of 12 o'clock noon on Monday, Oct. 20, 1890, for two pumping engines of the duplex type, each having a daily capacity of 10,000,000 gallons, together with necessary boilers for same, the whole to be in accordance with the general specifications, which may be obtained at the office of the superintendent of the department, City Hall, Toronto.

The tenders are received subject to the approval of the properly qualified electors being obtained to a by-law providing the necessary funds.

The lowest, or any, tender not necessarily accepted.

WM. J. HILL,
Chairman Committee on Water-Works.

CITY HALL, TORONTO, Sept. 19, 1890.
39-1t

Rushville, Ind., Water-Works.

Sealed proposals will be received by the Common Council of the City of Rushville, Ind., until 12 o'clock M. Nov. 3, 1890, under a franchise to be granted by said city, for the construction of a system of water-works.

A copy of said proposed franchise may be had on application to the Mayor of said city.

Security good for $500 must accompany each bid, either in money, certified check or bond signed by known parties, as a guarantee of good faith, the same to be returned when proposal is rejected or accepted and a satisfactory bond deposited with the Common Council of said city.

The city does not bind itself to accept the lowest or any bid.

WILSON T. JACKSON,
39-2t Mayor.

Notice to Contractors.

OFFICE OF THE COURT OF BURGESSES OF THE BOROUGH OF NORWALK, CONN.

Sealed proposals will be received at the Office of the Chairman of the Street Department, No. 29 Wall St., until 11 o'clock A. M. sharp of Wednesday, Oct. 8, 1890, for the construction of a Telford MacAdam road of about 3,600 ft. in length.

All excavation necessary is to be done by the contractor. Also the crushed stone to be used in the work, and a steam road roller are to be furnished by him. Profile and specifications can be seen, and all information obtained of C. N. Wood, Engineer, or of the Chairman of the Street Department, on and after Oct. 2, 1890.

The Court of Burgesses hereby reserve the right to reject any or all bids, or to accept any that in their judgment will be for the best interests of the Borough.

Bonds satisfactory to the Court in amount will be required of those to whom the contract may be awarded.

Cash, or a certified check made payable to the Treasurer of the Borough to the amount of $300 must accompany each bid, as a guarantee that in case the contract is awarded the party will, within three days after notification of award, execute said contract. All checks will be returned to the bidders submitting proposals as soon as the contract is awarded. Proposals must be endorsed upon the outside of the envelope with the name of the bidder, and marked proposal, and addressed to E. N. Sloan, Chairman of Street Committee.

E. N. SLOAN,
ISAAC BOWE,
E. S. ADAMS, } Street Committee.
39-2t

S. E. NOBLE, Prest. JNO. E. WARE, Secy. and Treas. R. F. CARTER, Supt.

The Anniston Pipe Works,

MANUFACTURERS OF

CAST IRON WATER AND GAS PIPE,

ANNISTON, - - - - ALA.

Especially adapted for the Elevation of Clear, Gritty, Thick, or Acidulous Liquids, Quickly, Cheaply and Efficiently

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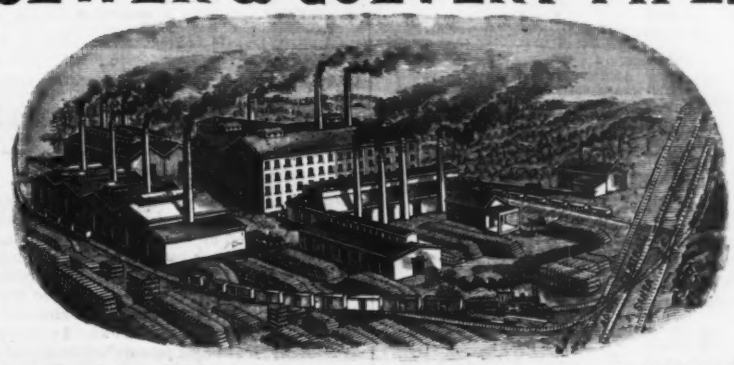
DOUBLE STRENGTH SEWER & CULVERT PIPE.



MONMOUTH MINING & MFG. CO., MONMOUTH, ILL.

SEA-WALL ON GOVERNOR'S ISLAND, New York Harbor, Engineer Office, U. S. Army, Room 74, Army Building, 39 Whitehall street, New York, N. Y., Oct. 1, 1890. Sealed proposals, in triplicate, will be received at this office until twelve (12) o'clock noon, on Friday, Oct. 31, 1890, for the construction of a Sea-Wall on Governor's Island, New York Harbor. The attention of bidders is invited to Acts of Congress approved Feb. 26, 1885, and Feb. 23, 1887, Vol. 23, page 332 and Vol. 24, page 414, Statutes at Large. Further information can be obtained at this office. D. C. HOUSTON Colonel of Engineers. 40-4t.

PROPOSALS FOR DREDGING IN SAvannah River, Ga.—United States Engineer Office, Savannah, Ga., Sept. 22, 1890.—Sealed proposals in triplicate will be received at this office until 12 o'clock M., city time, on Oct. 15, 1890, for dredging in Savannah River, Ga. Attention is invited to Acts of Congress approved Feb. 26, 1885, and Feb. 23, 1887, Vol. XXIII., page 332, and Vol. XXIV., page 414, Statutes at Large. For all necessary information apply to O. M. CARTER, First Lieutenant Corps of Engineers, U. S. A. 40-2t

PROPOSALS FOR STONE, MATTRESS and pile work in Savannah Harbor and River, Ga.—United States Engineer Office, Savannah, Ga., Sept. 22, 1890.—Sealed proposals in triplicate will be received at this office until 12 o'clock M., city time, on Oct. 20, 1890, for constructing training walls in the Savannah River, Ga. Attention is invited to Acts of Congress, approved Feb. 26, 1885, and Feb. 23, 1887, Vol. XXIII., page 332, and Vol. XXIV., page 414, Statutes at Large. For all necessary information apply to O. M. CARTER, First Lieutenant Corps of Engineers, U. S. A. 40-2t

U. S. ENGINEER OFFICE, Room 62, Army Building, New York, Sept. 24, 1890. Sealed proposals in triplicate will be received at this office until 12 o'clock noon, on October 25, 1890, for furnishing materials and constructing a pile wharf at Sandy Hook, N. J. The attention of bidders is invited to Acts of Congress approved Feb. 26, 1885, and Feb. 23, 1887, Vol. 23, page 332, and Vol. 24, page 414, Statutes at Large. For specifications, blank forms and all information, apply to the undersigned.
G. L. GILLESPIE, Lieut. Col. of Engineers.
39-4t

FORT RILEY, KANSAS, Sept. 25, 1890. Sealed proposals in triplicate, subject to usual conditions, will be received here until 3 P. M., Oct. 25, 1890, and then opened, for the construction of a cavalry drill hall 100 × 300 ft. Separate bids will be received for the combination truss roof. Plans and specifications can be seen at this office. The United States reserves the right to reject any or all bids. Envelopes containing proposals should be marked "Proposals for Drill Hall," and addressed to Captain Geo. E. Pond, Assistant Quartermaster, U. S. Army. 40-4t

Proposals for Grading, Improving and Macadamizing County Roads, in the County of Richmond.

Sealed proposals will be received at the place of meeting of the Board of Supervisors of Richmond County, N. Y, at the Village Hall, Stapleton, S. I., until Monday, Oct. 13, at 3 30 P. M., as follows:

For grading and otherwise improving county roads in accordance with maps, profiles and specifications on file in the Engineer's office. The quantity of work to be done is as follows:

TELFORD PAVEMENT.

Total length, miles	20 7 10
No. square yards, pavement	195,000
No. cubic yards, excavation	71,000

REPAIRS TO MACADAMIZED ROADS.

Total length, miles	3 8-10
No. square yards, repairs	65,000
No. cubic yards, broken stone required	3,600

TRAP OR GNEISS BLOCK PAVEMENT.

Old New York blocks can be used.

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No. square yards, pavement	35,250
No. cubic yards of excavation	7,000

Plans and specifications and also the conditions under which said proposals or bids shall be received, may be examined at the office of William S. Bacot, Engineer of County Roads, Old Village Hall, Stapleton, S. I.

Printed copies of the specifications and contract and also conditions under which said proposals or bids shall be received, may be had at the office of aforesaid Engineer.

The right to reject any or all bids for said work is reserved by said Board of Supervisors of Richmond County, as may be deemed for the best interests of the County, and notice is hereby given that the bids will be publicly opened at the meeting of the Board of Supervisors, to be held at the time and place above given.

By order of the Board of Supervisors.

CHARLES M. TODD,
Dated Sept. 15, 1890. Clerk, *pro tem*,
P. O. Address, Tompkinsville, S. I.
38-3t

Notice to Contractors.

Sealed proposals will be received at the office of the Recorder of Albuquerque, New Mexico, until two o'clock P. M., on the first day of November, 1890, for constructing sewers in the town of Albuquerque, Bernalillo Co., New Mexico.

Forms of proposals, copies of specifications and instructions to contractors may be obtained of the Recorder or of the Engineer, and the plans and profiles may be seen at the office of either of the above named parties.

Each bid must be accompanied by a deposit of one thousand dollars ($1,000) as a guarantee of the good faith of the bidder.

The Board of Trustees reserve the right to reject any or all bids.

Address
HENRY LOCKHART, Recorder,
Albuquerque, N. M.

W. KIERSTED, Engineer,
620 Keith & Perry Building,
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To Contractors.

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FRANK MATHEWS,
Chief Engineer K. I. C. & D. Co.,
39-2t Pineville, Ky.

To Masonry Contractors.

AMERICUS, GA., Sept. 16, 1890.

Bids will be received for the construction of four (4) brick piers, with pile foundations, on the Savannah, Americus & Montgomery Ry., till Oct. 10.

Apply for plans and specifications to
J. C. WRIGHT,
38—2t Engr. in Charge.

PROPOSALS FOR CONSTRUCTION OF RIP RAP FOUNDATION.—U. S. Engineer office, Cleveland, O., Sept. 29th, 1890. Sealed proposals, in duplicate, will be received at this office until 12 o'clock M. on Thursday, the 16th day of October next, at which time they will be opened in the presence of bidders, for constructing 450 lineal feet, more or less, of rip rap foundation for breakwater at Cleveland, Ohio. All information can be obtained at this office. The United States reserves the right to reject any or all proposals.

Preference will be given to materials and plant of domestic production or manufacture, conditions of quality and price (import duties included) being equal. The attention of bidders is invited to the acts of Congress approved February 26th, 1885, and February 23d, 1887, Vol. 23, page 332, and Vol. 24, page 414, Statutes at Large. L. Cooper Overman, Major of Engineers. 40-2t.

Contract Drawings of the New Croton Aqueduct.

From Croton Dam to Harlem River.

Plates 1 and 2.—Map and profile showing the route of the new Croton Aqueduct, location of shafts, blow-off and waste weirs, also route of the present aqueduct.

Plate 3.—Sheet No. 11, general form of aqueduct at north side of Harlem River. Sheet No. 3½ shows beginning of aqueduct at Croton River.

Plate 4.—Sheets No. 4, 4½ and 16 show tunnel excavation and masonry in various kinds of material.

Plate 5.—Sheet No. 5, Figs. 1 and 2, also sheet No. 6, show aqueduct under pressure in rock tunnel. Sheet No. 6½ shows aqueduct where it is in rock tunnel.

Plate 6.—Sheets Nos. 7 and 7½, general form of aqueduct in rock tunnel.

Plate 7.—Sheets Nos. 8, 8½ and 8½, aqueduct without masonry, except floor. Sheet No. 25, aqueduct in earth and rock, water pressure overhead.

Plate 8.—Sheets Nos. 9 and 9½, tunnel excavation and masonry.

Plate 9.—Sheets Nos. 17, 18 and 20, aqueduct in rock tunnel. Sheets No. 19, Fig. 1, aqueduct on flooring. Fig. 2, on piles.

Plate 10.—Sheet No. 21, aqueduct in compact and loose rock. Sheets Nos. 22 and 23, aqueduct in earth. Sheet No. 24, aqueduct in tunnel requiring support.

Plate 11. Sheet No. 13, shaft for aqueduct under pressure, south of Yonkers.

Plate 12.—Sheet No. 14, shaft for aqueduct under pressure, south of Yonkers.

Plate 13.—Sheet No. 15, masonry for shafts, aqueduct not under pressure.

Plate 14.—Sheet No. 31, blow-off and waste weir, to be built at South Yonkers.

Plate 15.—Sheet No. 28, blow-off and waste weir at Ashford on Saw Mill River.

Plate 16.—Sheet No. 26, blow-off and waste weir at Pocantico River.

Also, table of bids and prices.

This Volume of Drawings was prepared and published by the Chief Draughtsman of the New Croton Commission in 1885. They are photographic reproductions of the working drawings, reduced to a page 9 inches by 12 inches, each sheet being signed by the Chief Engineer, B. S. Church.

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WANTED.—To sell back volumes of London *Engineering*. Have also number of odd numbers, loose, and several indexes for sale. State dates of what you need and price you will pay. Address "F. A. P.," Engineering News, New York. 39-2t

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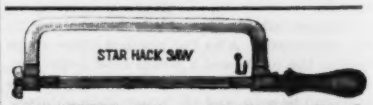

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